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MATHEMATICS

Quarter 1 - Module 6:
Proving the Remainder Theorem, Factor Theorem and the Rational Root Theorem

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MATHEMATICS 10
Quarter 1 - Module 6: Proving the Remainder Theorem, Factor Theorem and the Rational Root Theorem
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MATHEMATICS

Quarter 1 - Module 6:
Proving the Remainder Theorem, Factor Theorem and the Rational Root Theorem

Introductory Message

This Self-Learning Module (SLM) is prepared so that you, our dear learners, can continue your studies and learn while at home. Activities, questions, directions, exercises, and discussions are carefully stated for you to understand each lesson.

Each SLM is composed of different parts. Each part shall guide you step-by-step as you discover and understand the lesson prepared for you.

Pre-tests are provided to measure your prior knowledge on lessons in each SLM. This will tell you if you need to proceed on completing this module or if you need to ask your facilitator or your teacher's assistance for better understanding of the lesson. At the end of each module, you need to answer the post-test to self-check your learning. Answer keys are provided for each activity and test. We trust that you will be honest in using these.

In addition to the material in the main text, Notes to the Teacher are also provided to our facilitators and parents for strategies and reminders on how they can best help you on your home-based learning.

Please use this module with care. Do not put unnecessary marks on any part of this SLM. Use a separate sheet of paper in answering the exercises and tests. And read the instructions carefully before performing each task.

If you have any questions in using this SLM or any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator.

Thank you.

Target

In the previous lesson, you have learned how to divide polynomials using long division and synthetic division and how to express the result of division in terms of the quotient and remainder.

In this module, you will learn a new method of finding the remainder when a polynomial is divided by x – r. You will also learn a method of determining whether or not x – r is a factor of a given polynomial.

After going through this module, you are expected to "prove the remainder theorem, factor theorem and the rational root theorem" **(M10AL-1g-1).**

Specifically, you should be able to:

1. evaluate polynomials
2. find the remainder using the Remainder Theorem
3. apply the Factor Theorem to show that x – c is a factor of P(x)
4. determine the possible rational zeros of a polynomial function

> Before you start doing the activities in this lesson, find out how much you already know about this module. Answer the pre-test below in a separate sheet of paper.

Pre-Assessment

Direction: Choose the letter of the correct answer and write it on a separate sheet of paper.

1) When P(x) is divided by x-r and the remainder is equal to zero, it means that ___?
   A) x – r is a factor of P(x) B) P(x) is a factor of x – r
   C) x – r is not a factor of P(x) D) P(x) is not a factor of x – r

2) Which of the following binomials is a factor of P(x) = $x^3 - 7x + 5$?
   A) x – 1 B) x + 1 C) x + 2 D) none of these

3) Which of the following is the missing factor in the equation $x^2 - 4 = (x - 2)(\_\_\_\_\_)$?
   A) x - 2 B) x + 2 C) x + 4 D) x – 4

4) If $(7x^4 - 5x^5 - 7x^3 + 2x - 3)$ is divided by (x + 3) using synthetic division, what would be the numbers in the first row?
   A) -5 7 -7 0 2 -3 B) -7 -7 -5 0 2 -3
   C) 1 7 -7 0 2 -3 D) -3 7 -7 0 2 -5

5) Which of the following is **NOT** a factor of $x^3 + 5x^2 - x - 5$?

A) $x + 1$ B) $x - 1$ C) $x - 5$ D) $x + 5$

6) How many positive real roots does $x^4 - x^3 - 11x^2 + 9x + 18 = 0$ have?
A) 0 B) 1 C) 2 D) 3

7) What are the factors of $x^2 - 2x - 24$?
A) $(x + 4)(x - 6)$ B) $(x - 8)(x + 3)$
C) $(x -12)(x + 1)$ D) $(x + 12)(x - 12)$

8) What is the remainder when $x^3 - 4x^2 + x + 8$ is divided by $x - 2$?
A) 1 B) 2 C) 3 D) 4

9) Which polynomial gives a remainder of 0 when divided by $3x - 2$?
A) $12x^2 + 15x - 18$ B) $12x^2 + 18x + 7$
C) $12x^2 + 19x - 18$ D) $12x^2 + 8x + 7$

10) Which of the following is a factor of $2x^2 - 5x + 3$?
A) $x - 3$ B) $2x + 3$ C) $x - 1$ D) $3x + 2$

11) What is the remainder if $x^2 - 7x - 4$ is divided by $x - 2$?
A) -14 B) 5 C) 6 D) 7

12) Which of the following statement is true?
A) If you multiply the quotient and the remainder, it is equal to the dividend.
B) If $x^2 + 5x + 7$ is divided by $x + 2$, the remainder is 1.
C) If the remainder is 0, then the dividend is a factor of the divisor.
D) The remainder is a factor of the dividend if the quotient is 0.

13) What is the remainder if $2x^3 - 7x^2 - 19x + 20$ is divided by $x - 5$?
A) -1 B) 0 C) 1 D) 2

14) One of the roots of the polynomial equation $2x^3 + 9x^2 - 33x + 14 = 0$ is 2. Find the other roots.
A) ½ and 7 B) -½ and 7 C) ½ and -7 D) -½ and -7

15) Find another factor of $x^3 - 7x^2 + 4x - 28$ if $x - 7$ is a factor.
A) $x^2 + x + 4$ B) $x^2 - 2x - 4$ C) $x^2 - x - 4$ D) $x^2 + 4$

Lesson 1	The Remainder Theorem

Jumpstart

In this lesson, you will learn a new method of finding the remainder when a polynomial is divided by x – r. Before that, you first need to recall your lessons on evaluating polynomials.

Activity 1: Message under the Table

Evaluate the polynomial at the given values of x. Choose the letter in the box that matches your answer then write the letter above the corresponding number in the table below to decode the message.

A. $P(x) = x^3 + x^2 + x + 3$

1. x = - 3
2. x = - 2
3. x = - 1
4. x = 0
5. x = 1
6. x = 2
7. x = 3

A →	**-2**	**O** →	**3**
E →	**- 18**	**P** →	**- 42**
C →	**- 6**	**R** →	**17**
H →	**2**	**S** →	**42**
M →	**- 3**	**T** →	**6**

5	**3**	**1**	**4**	**6**	**1**	**2**	**7**

Guide Questions:

1. How did you find the value of a polynomial expression P(x) at a given value of x?
2. What message did you obtain?
3. Did the activity help you recall how to evaluate a polynomial at the given value?

Consider this division:

$$
\begin{array}{r|l}
 & \quad x^2 - x - 1 \\ \cline{2-2}
x - 2 & x^3 - 3x^2 + x + 4 \\
 & \underline{x^3 - 2x^2} \\
 & \qquad -x^2 + x \\
 & \qquad \underline{-x^2 + 2x} \\
 & \qquad\qquad -x + 4 \\
 & \qquad\qquad \underline{-x + 2} \\
 & \qquad\qquad\quad 2 \quad \longleftarrow \text{remainder}
\end{array}
$$

The quotient here is $x^2 - x - 1$, and the remainder is 2. This result may also be expressed as $x^2 - x - 1 + \frac{2}{x-2}$. This means that there is a difference of 2 between the dividend $x^3 - 3x^2 + x + 4$, and the product of the quotient $x^2 - x - 1$ and the divisor $x - 2$.

Discover

To find the remainder when an expression is divided by a given linear expression, we use the Remainder Theorem.

REMAINDER THEOREM

If a polynomial P(x) is divided by x – c, then the remainder is a constant denoted by P(c).

Proof of the Remainder Theorem

Let P(x) be the dividend and x – c be the divisor, the remainder when P(x) is divided by x – c can be written in the relation:

$\frac{P(x)}{x-c} = Q(x) + \frac{R}{x-c}$

$P(x) = (x - c)\,Q(x) + R$	Multiply both sides of the equation by *x* - *c*
$P(c) = (c - c)\,Q(x) + R$	Replace *x* by *c*
$\quad = 0 \bullet Q(x) + R$	Simplify
$\quad = 0 + R$	
$\quad = R$	

Thus, if *P(x)* is divided by *x – c*, the remainder is *P(c)*.

Example 1: Find the remainder when $(x^4 - 3x^3 - 2x^2 + 5x - 6)$ is divided by $(x - 3)$.

Solution:

a. Using the Remainder Theorem

$P(x) = x^4 - 3x^3 - 2x^2 + 5x - 6$

Since $x - c = x - 3$,

then $x = 3$

Therefore, $P(3) = (3)^4 - 3(3)^3 - 2(3)^2 + 5(3) - 6$

$= 81 - 81 - 18 + 15 - 6$

$= -9 \longrightarrow$ remainder

b. Check using Synthetic Division

$$\begin{array}{r|rrrrr} 3 & 1 & -3 & -2 & 5 & -6 \\ & & 3 & 0 & -6 & -3 \\ \hline & 1 & 0 & -2 & -1 & -9 \end{array}$$

Thus, the remainder is -9.

Example 2: Find the remainder when P(x) = $2x^4 + 5x^3 + 2x^2 - 7x - 15$ is divided by (2x – 3).

Solution:

a. Using the Remainder Theorem

$P(x) = 2x^4 + 5x^3 + 2x^2 - 7x - 15;\ x = \frac{3}{2}$

$P(\frac{3}{2}) = 2(\frac{3}{2})^4 + 5(\frac{3}{2})^3 + 2(\frac{3}{2})^2 - 7(\frac{3}{2}) - 15$

$= 2(\frac{81}{16}) + 5(\frac{27}{8}) + 2(\frac{9}{4}) - \frac{21}{2} - 15$

$= 6$

b. Check using Synthetic Division

$$\begin{array}{r|rrrrr} \frac{3}{2} & 2 & 5 & 2 & -7 & -15 \\ & & 3 & 12 & 21 & 21 \\ \hline & 2 & 8 & 14 & 14 & 6 \end{array}$$

Thus, the remainder is 6.

Example 3:Use the Remainder Theorem to find the remainder when $x^4 - 3x^3 + 2x-2$ is divided by x + 2.

Solution:

a. Using the Remainder Theorem

$P(x) = x^4 - 3x^3 + 2x - 2;\ x = -2$

$P(-2) = (-2)^4 - 3(-2)^3 + 2(-2) - 2$

$= 16 + 24 - 4 - 2$

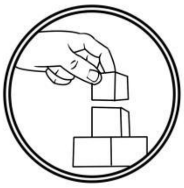
$= 34$ is the remainder

b. Check using Synthetic Division

$$\begin{array}{r|rrrrr} -2 & 1 & -3 & 0 & 2 & -2 \\ & & -2 & 10 & -20 & 36 \\ \hline & 1 & -5 & 10 & -18 & 34 \end{array}$$

Thus, the remainder is 34.

Now that you know the important ideas about the topic, you may now proceed to the next activities.



Explore

Activity 2: Remainder Theorem

Find the remainder when the first polynomial is divided by the second polynomial. Use the Remainder Theorem and check using Synthetic Division.

1) $a^3 - 3a^2 - a + 20; \quad a + 2$
2) $x^3 + 14x^2 + 47x - 12; \quad x + 7$
3) $2x^3 - 15x^2 + 11x + 10; \quad x - 5$
4) $x^3 - 2x^2 + 5x + 6; \quad -2x + 1$
5) $y^3 - 3y + 2; \quad y - 1$

Activity 3: Think of this:

What is the positive integer which has

1) a remainder of 1 when divided by 2?
2) a remainder of 2 when divided by 3?
3) a remainder of 3 when divided by 5?
4) a remainder of 5 when divided by 7?

Here is another activity that lets you apply what you have learned about the Remainder Theorem.

Deepen

Activity 4: Applying the Remainder Theorem

Use the Remainder Theorem to find the remainder when the given polynomial is divided by each binomial. Verify your answer using synthetic division.

1. $P(x) = x^3 - 7x + 5$

   a. $x - 1$ b. $x + 1$ c. $x - 2$

2. $P(x) = 4x^4 - 3x^3 - x^2 + 2x + 1$

   a. $x - 1$ b. $x + 1$ c. $x - 2$

3. $P(x) = 8x^4 + 12x^3 - 10x^2 + 3x + 27$

   a. $2x - 3$ b. $2x + 3$ c. $3x - 2$

Lesson 2 The Factor Theorem

Jumpstart

In this lesson, you will learn to factor easily a polynomial P(x) of degree greater than 2 by using the Factor Theorem.

Consider $P(x) = x^3 + 4x^2 + x - 6$. If P(x) is divided by x + 2, what is the remainder? Using the remainder theorem, we have:

$P(x) = x^3 + 4x^2 + x - 6$
$P(-2) = (-2)^3 + 4(-2)^2 + (-2) - 6$
$= 0$

Since the remainder is zero, x + 2 is a factor of $x^3 + 4x^2 + x - 6$. This illustrates a special case of the remainder theorem which is the Factor Theorem.

Discover

Sometimes, the remainder when P(x) is divided by (x – r) is 0. This means that x – r is a factor of P(x). Equivalently, P(r) = 0. This idea is illustrated by the Factor theorem.

FACTOR THEOREM
The polynomial P(x) has x – r as a factor if and only if P(r) = 0.

There are two parts of the proof of the Factor Theorem, namely:
Given a polynomial P(x),
1. If x – r is a factor of P(x), then P(r) = 0.
2. If P(r) = 0, then x – r is a factor of P(x).

Activity 5: Proving the Factor Theorem
Fill-in the blanks to complete the statement. Write your answers in your paper.

1. x – r is a factor of P(x) if and only if the remainder R of P(x) ÷ (x – r) is ____.

2. By the remainder theorem, R = 0 if and only if ____.

3. Thus, x – r is a factor of P(x) if and only if ____.

Example 1: Show that x + 1 is a factor of $2x^3 + 5x^2 - 3$

Solution: Using the Factor Theorem, we have:

$$P(x) = 2x^3 + 5x^2 - 3$$
$$P(-1) = 2(-1)^3 + 5(-1)^2 - 3$$
$$= -2 + 5 - 3$$
$$= 0$$

Since $P(-1) = 0$, then $x + 1$ is a factor of $2x^3 + 5x^2 - 3$.

Example 2: Show that $x - 2$ is a factor of $x^4 + x^3 - x^2 - x - 18$.

Solution:

Let $P(x) = x^4 + x^3 - x^2 - x - 18$
$$P(2) = 2^4 + 2^3 - 2^2 - 2 - 18$$
$$= 16 + 8 - 4 - 2 - 18$$
$$= 0$$

By the Factor Theorem, $x - 2$ is a factor of $x^4 + x^3 - x^2 - x - 18$

Example 3: Find a polynomial function of minimum degree whose zeros are -2, 1,-1

Solution: By the factor theorem, the polynomial must have the following as factors, $(x + 2)\ (x - 1)$ and $(x + 1)$.

Thus, $P(x) = (x + 2)\ (x - 1)\ (x + 1)$
$$= (x + 2)\ (x^2 - 1)$$
$$= x^3 + 2x^2 - x - 2$$

Example 4: Find *k* so that $x + 1$ is a factor of $P(x) = kx^3 - 5x^2 + kx + 11$.

Solution: using Synthetic Division

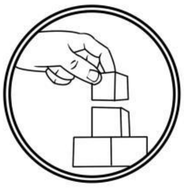
$$\begin{array}{r|rrrr} -1 & k & -5 & k & 11 \\ & & -k & k+5 & -2k-5 \\ \hline & k & -k-5 & 2k+5 & -2k+6 \end{array}$$

The remainder must be 0 so that we have the statement,
$$-2k + 6 = 0$$
$$-2k = -6$$
$$k = 3$$

Thus, the polynomial $P(x) = 3x^3 - 5x^2 + 3x + 11$ has $x + 1$ as one of its factors.

Check: $P(x) = 3x^3 - 5x^2 + 3x + 11$
$$P(-1) = 3(-1)^3 - 5(-1)^2 + 3(-1) + 11$$
$$= 3(-1) - 5(1) - 3 + 11$$
$$= -3 - 5 - 3 + 11$$
$$= -11 + 11$$
$$P(-1) = 0$$

This shows that the obtained value of *k* is correct.



Explore

Activity 6: Factor Theorem

A. Determine whether the second polynomial is a factor of the first by using the Factor Theorem.
   1. $4x^7 - 2x^6 + x^2 + 2x + 5$; $x - 1$
   2. $a^6 - a^5 - 7a^4 + a^3 + 8a^2 + 5a + 2$; $a + 2$
   3. $2x^3 + 2x^2 - 3x - 4$; $x + 5$
   4. $2x^4 + 7x^3 + 5x^2 - 8x - 4$; $2x + 1$
   5. $x^4 + 2x^3 - 8x - 16$; $x + 2$

B. Fill in the blank with the missing factor in each of the following using synthetic division.
   1. $x^3 - 3x + 2$; $(x - 1)$ and ___________
   2. $2x^3 - 3x^2 - 23x + 42$; $(2x + 7)$ and ___________
   3. $x^3 - 6x^2 + 11x - 6$; $(x - 2)$ and __________

Here is another activity that lets you apply what you have learned about the Factor Theorem.

Deepen

Activity 7: Applying the Factor Theorem

A. Use the factor theorem to find whether the first polynomial is a factor of the second.
   1. $x + 1$; $x^3 + x^2 + x + 1$
   2. $x + 2$; $x^8 + 2x^7 + x + 2$
   3. $a - 1$; $a^3 - 2a^2 + a - 2$
   4. $x - 2$; $4x^3 - 3x^2 - 8x - 4$
   5. $y - 2$; $3y^4 - 6y^3 - 5y + 10$

B. Find a polynomial function with integral coefficients that has the given numbers as roots.
   1. 0, 1, -2
   2. -1, 2, -3
   3. 1, 1, 3
   4. -2, 4
   5. 1, -1

Lesson 3 The Rational Root Theorem

Jumpstart

In this lesson, we will relate the possible roots/zeros of a polynomial (having integer coefficients) to the leading coefficient a_n and to the constant term a_0.

Let us start by examining the following polynomial function:

$$P(x) = (5x + 1)(x - 2)(x + 3)$$
$$= 5x^3 + 6x^2 - 29x - 6$$

Roots/Zeros of P(x) = $-\frac{1}{5}, 2, -3$

Notice that the numerators, -1, 2, and -3 of the roots or zeros of P(x) are both integer factors of the constant term -6. The denominator 5, is a factor of 5, the leading coefficient in P(x). These observations are stated in the theorem below.

Discover

To find the rational roots or zeros of any polynomial function with integral coefficients, another theorem may be used. In this connection, remember that every rational number can be written as a quotient of relatively prime integers.

RATIONAL ROOT/ZERO THEOREM

If the rational number $\frac{p}{q}$ in lowest term is a root or zero of the polynomial, $P(x) = a_n x^n + a_{n-1}x^{n-1} + a_{n-2}x^{n-2} + \cdots + a_1 x + a_0$ with integer coefficients, then p and q must be integer factors of a_0 and a_n respectively.

In short, the theorem enables us to list all possible zeros of P(x) if any exists. Thus, it lessens the possibilities of the numbers we test for zero remainder in the synthetic division when we look for the zeros of the function.

Note: To find other roots or zeros, either use synthetic division or the remainder theorem.

Example 1: List all possible rational zeros of $P(x) = 2x^3 + x^2 - 13x + 6$.

Solution: If $\frac{p}{q}$ in lowest term is a rational zero of P(x), then p must be a factor of 6 and q must be a factor of 2.

Possible values of p: $\pm1, \pm2, \pm3, \pm6$
Possible values of q: $\pm1, \pm2$
Possible values of $\frac{p}{q}$: $\pm1, \pm\frac{1}{2}, \pm2, \pm3, \pm\frac{3}{2}, \pm6$

Thus, if P(x) has rational zeros, they must be in the list of possible values of $\frac{p}{q}$.

Example 2: Find the rational zeros of $P(x) = 2x^3 + x^2 - 13x + 6$.

Solution: From the Rational Zero Theorem, we list down the possible roots
$\frac{p}{q}$: $\pm1, \pm\frac{1}{2}, \pm2, \pm3, \pm\frac{3}{2}, \pm6$

Using Synthetic Division to find the root:

$$\begin{array}{r|rrrr} 2 & 2 & 1 & -13 & 6 \\ & & 4 & 10 & -6 \\ \hline & 2 & 5 & -3 & 0 \end{array}$$

Thus, x = 2 is a root or zero of P(x). The depressed equation $2x^2 + 5x - 3$ is now a quadratic equation and its factors are:
$2x^2 + 5x - 3 = (2x - 1)(x + 3)$

The other zeros of P(x) are, x = -3 and ½

Therefore, the rational zeros of P(x) are 2, ½, and -3. Notice that these are found in the list of possible roots of P(x).

Example 3: Find the rational zeros of $x^3 + 2x + 1$.

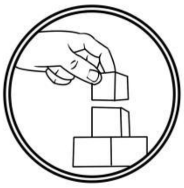
Solution:
Possible values of p: ±1
Possible values of q: ±1
Possible values of $\frac{p}{q}$: ±1

By testing these possible zeros using the Remainder Theorem:
$P(1) = 1^3 + 2(1) + 1 = 4$
$P(-1) = (-1)^3 + 2(-1) + 1 = -2$

We see that neither are zeros of P(x).

We conclude that P(x) has no rational zeros/roots.

Now that you know the important ideas about the topic, you may now proceed to the next activities.



Explore

Activity 8: Find the rational zeros of the polynomial function if they exist. If possible, find the other zeros.

1. $P(x) = x^3 - x^2 - 3x + 3$
2. $P(x) = 2x^3 - 3x^2 - 7x - 6$
3. $P(x) = 5x^3 - x^2 - 15x + 3$

Here is another activity that lets you apply what you have learned about the Rational Root Theorem.

Deepen

Activity 9: For each polynomial, list all possible rational zeros and find all rational zeros. If there are no rational zeros, write NONE.

1. $P(x) = x^3 + 2x^2 - 5x - 6$
2. $P(x) = 2x^3 - x^2 - 8x + 4$
3. $P(x) = x^3 - 2x^2 - 5x + 6$

Gauge

DIRECTION: Let us determine how much you have learned from this module. Read and understand each item, then choose the letter of your answer and write it on your paper.

1. What is the remainder if $x^2 - 7x - 4$ is divided by $x - 2$?
   A) -14 B) -2 C) 2 D) 4

2. Which of the following statements is true?
   A) If you multiply the quotient and the remainder, it is equal to the dividend.
   B) If $x^2 + 5x + 7$ is divided by $x + 2$, the remainder is not 1.
   C) If the remainder is 0, then the dividend is a factor of the divisor.
   D) The quotient is a factor of the dividend if the remainder is 0.

3. What is the remainder if $2x^3 + 4x^2 - x + 7$ is divided by $x - 2$?
   A) 35 B) 36 C) 37 D) 38

4. Given $P(x) = x^4 - 3x^3 - x + 3$, which of the following is its factors?
   A) $x + 2$ B) $x + 3$ C) $x + 4$ D) $x + 5$

5. Find another factor of $x^3 - 7x^2 + 4x - 28$ if $x - 7$ is a factor.
   A) $x^2 + x + 4$ B) $x^2 - 2x - 4$ C) $x^2 - x - 4$ D) $x^2 + 4$

6. Determine which of the following binomials is a factor of $P(x) = x^3 - 7x + 5$.
   A) $x - 1$ B) $x + 1$ C) $x + 2$ D) none of these

7. Which is the missing factor in the equation $x^2 - 4 = (x - 2)$ (_____)?
   A) $x - 2$ B) $x + 2$ C) $x + 4$ D) $x - 4$

8. What are the factors of $x^2 - 2x - 24$?
   A) $(x + 4)(x - 6)$ B) $(x - 8)(x + 3)$
   C) $(x - 12)(x + 1)$ D) $(x + 12)(x - 12)$

9. What is the remainder when $x^3 - 4x^2 + x + 8$ is divided by $x - 2$?
   A) 1 B) 2 C) 3 D) 4

10. When $P(x)$ is divided by $x - r$ and is equal to 0, it means that _____.
    A) $x - r$ is a factor of $P(x)$ B) $P(x)$ is not a factor of $x - r$
    C) $P(x)$ is a factor of $x - r$ D) $x - r$ is the only factor of $P(x)$

11. Which of the following is a factor of $2x^2 - 5x + 3$?
    A) $x - 3$ B) $2x + 3$ C) $x - 1$ D) $3x + 2$

12. Find *k* so that $(x - 2)$ is a factor of $x^3 + kx - 4$.
    A) -3 B) -2 C) -1 D) 0

13. Which of the following is **NOT** a root of $x(x + 3)(x + 3)(x - 1)(2x + 1) = 0$?

i. 0 ii. -3 iii. -1 iv. ½

A) i only B) ii only C) i and ii only D) iii and iv only

14. How many positive real roots does $x^4 - x^3 - 11x^2 + 9x + 8 = 0$ have?

A) 0 B) 1 C) 2 D) 3

15. If $P(-2) = 0$, which of the following statements is true about $P(x)$?

A) $x + 2$ is a factor of $P(x)$
B) 2 is a root of $P(x) = 0$
C) $P(x) = 0$, has two negative roots
D) $P(0) = -2$

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ELECTRONIC RESOURCES

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