Polynomials

6.1 Operate with polynomials

CCSS	4 – Mastery	3 – Proficient	2 - Basic	1 – Below Basic	0 – No Evidence
Operations with polynomials (A.APR.1)	Can extend thinking beyond the standard, including tasks that may involve one of the following: • Designing • Connecting • Synthesizing • Applying • Justifying • Critiquing • Analyzing • Creating • Proving	Add, subtract and multiply polynomials with integers **within the same problem**	Add and subtract polynomials with integers **and multiply** polynomials with integers	**Add and subtract polynomials** with integers	Little evidence of reasoning or application to solve the problem Does not meet the criteria in a level 1
Rewrite polynomial expressions (A.SSE.2, A.APR.4)		Rewrite polynomial expressions in different equivalent forms by using **all of the following:** ● greatest common factors ● difference of two squares ● trinomials ● quadratic-like trinomials (degree 4 or higher) ● sums or difference of cubes	Rewrite polynomial, rational, and exponential expressions in different equivalent forms by doing **4 of the following**: ● greatest common factors ● difference of two squares ● trinomials ● quadratic-like trinomials (degree 4 or higher) ● sums or difference of cubes	Rewrite polynomial, rational, and exponential expressions in different equivalent forms by doing **3 of the following**: ● greatest common factors ● difference of two squares ● trinomials ● quadratic-like trinomials (degree 4 or higher) ● sums or difference of cubes	
Interpret expressions (A.SSE.1)		Interpret individual parts of polynomial expressions (such as variables, coefficients, factors, etc.) **and explain their meaning in terms of the context** Group parts of polynomial expressions and interpret their meaning **in terms of the context**	**Interpret** individual parts of polynomial expressions (such as variables, coefficients, factors, etc.) Group parts of a polynomial expressions and **interpret their meaning**	**Identify** individual parts of polynomial expressions (such as variables, coefficients, factors, etc.) **Identify groups** in polynomial expressions	

A.APR.1 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.

A.APR.4 Prove polynomial identities and use them to describe numerical relationships. *For example, the polynomial identity* $(x^2 + y^2)^2 = (x^2 – y^2)^2 + (2xy)^2$ *can be used to generate Pythagorean triples.*

A.SSE.2 Use the structure of an expression to identify ways to rewrite it. *For example, see* $x^4 – y^4$ *as* $(x^2)^2 – (y^2)^2$, *thus recognizing it as a difference of squares that can be factored as* $(x^2– y^2)(x^2 + y^2)$.

A.SSE.1 Interpret expressions that represent a quantity in terms of its context.★
a. Interpret parts of an expression, such as terms, factors, and coefficients.
b. Interpret complicated expressions by viewing one or more of their parts as a single entity. *For example, interpret* $P(1+r)$n *as the product of P and a factor not depending onP.*

Polynomials

6.2 Explore polynomial factors

CCSS	4 – Mastery	3 – Proficient	2 - Basic	1 – Below Basic	0 – No Evidence
Apply the Remainder Theorem (A.APR.2, A.APR.6)	Can extend thinking beyond the standard, including tasks that may involve one of the following: • Designing • Connecting • Synthesizing • Applying • Justifying • Critiquing • Analyzing • Creating • Proving	Factor a polynomial using either synthetic division or long division, writing $\frac{a(x)}{b(x)}$, in the form $q(x)+\frac{r(x)}{b(x)}$ **and identify** • if p(a) is zero, then (x-a) is a factor • if p(a) is not zero, then (x-a) is not a factor • p(a) is the remainder when dividing p(x) by x-a. • the remainder is equivalent to p(a)	Can perform synthetic or long division **correctly and are able to state the remainder, writing** $\frac{a(x)}{b(x)}$, in the form $q(x)+\frac{r(x)}{b(x)}$	Can perform synthetic or long division **with a structural error, but were able to follow through with their mistake**	Little evidence of reasoning or application to solve the problem Does not meet the criteria in a level 1
Identify zeros (A.APR.3, A.SSE.3)		Identify the zeros of a polynomial using **multiple methods of factoring, which may include using synthetic division**	Identify the zeros of a polynomial **using two methods of factoring**	Identify the zeros of a polynomial **using a single method of factoring**	

A.APR.2 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 $p(x)$.

A.APR.6 Rewrite simple rational expressions in different forms; write a(x)/b(x) in the form q(x) + r(x)/b(x), where a(x), b(x), q(x), and r(x) are polynomials with the degree of r(x) less than the degree of b(x), using inspection, long division, or, for the more complicated examples, a computer algebra system.

A.SSE.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.*

a. Factor a quadratic expression to reveal the zeros of the function it defines.

A.APR.3 Identify zeros of polynomials when suitable factorizations are available, ~~and use the zeros to construct a rough graph of the function defined by the polynomial.~~

Polynomials

6.3 Analyze polynomial functions

CCSS	4 – Mastery	3 – Proficient	2 - Basic	1 – Below Basic	0 – No Evidence
Identify zeros to construct graphs (A.APR.3)	Can extend thinking beyond the standard, including tasks that may involve one of the following: • Designing • Connecting • Synthesizing • Applying • Justifying • Critiquing • Analyzing • Creating • Proving	Identify the zeros of a polynomial function in **standard form** and use the zeros as one of the criteria to construct a rough graph of the function	Identify the zeros of a polynomial function in **factored form** and use the zeros of the function as one of the criteria to construct a **rough graph of the function**	Identify the zeros of a polynomial function in **factored form and can only correctly graph the zeros**.	Little evidence of reasoning or application to solve the problem Does not meet the criteria in a level 1
Average rate of change (F.IF.6)		Calculate the average rate of change over a given interval **and explain the meaning in context.**	**Calculate** the average rate of change over a given interval	**Describe** the average rate of change over a given interval	
Graph and interpret polynomial functions (F.IF.4, F.IF.7c) *Can use technology*		Graph polynomial functions and **interpret all key features** of the graph in the context of a situation Translate a verbal description of a relationship to **sketch** a polynomial graph Identify an appropriate domain **based on the context** from both graphs **and** verbal/written descriptions Identify the meaning of a point from both graphs **and** verbal/written descriptions **in terms of the context**	Graph polynomial functions and **interpret some key features** of the graph in the context of a situation Translate a verbal description of a graph's key features to **sketch** a polynomial graph Identify an appropriate domain **based on the context** from graphs **or** verbal/written descriptions Identify the meaning of a point from a graph **or** verbal/written description **in terms of the context**	Graph polynomial functions and **identify key features** of the graph Translate a verbal description of a graph's key features to **identify** a polynomial graph Identify the domain from graphs **or** verbal/written descriptions Identify the meaning of a point from a graph **or** verbal/written description	
Create polynomial equations (A.CED.1)		Create a polynomial equation in **expanded form** given the zeros, multiplicity, and leading coefficient	Create a polynomial equation in factored form given the zeros, **multiplicity, and leading coefficient**	Create a polynomial equation in **factored form given the zeros**	

A.APR.3 Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.

F.IF.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. *Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*★

F.IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases
c. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.

F.IF.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.★

A.CED.1 Create equations ~~and inequalities~~ in one variable and use them to solve problems.