Polynomial Graph-Matching Card Sort

TEACHER GUIDE

Teacher instructions and answer key

What this activity tests

Students connect algebraic structure to visible graph behavior. A complete match forces them to reconcile zeros, cross-or-touch behavior, end behavior, degree parity, and leading sign instead of identifying a graph from a single clue.

STATION / PARTNER

Print one level single-sided. Cut on the dashed borders, shuffle by category, and set out eight labeled stacks. Students build one family at a time and record every code.

REVIEW DAY

Give pairs the full set but require a spoken defense before a match is placed. Ask which root crosses, which one turns, and what the tails force the degree and sign to be.

SUBSTITUTE PLAN

Use the uncut version. Students write graph letters in the boxes and finish the two written justifications. The key checks quickly without handling cards.

Suggested pacing

5 min	Sort the cards into the eight representation categories.
12-25 min	Build the function families and record the card codes.
8-12 min	Compare with a partner and settle disagreements with graph evidence.
5 min	Debrief: one even multiplicity, one odd multiplicity, one end-behavior example.

FROM THE TUTORING DESK

The mistake I see most often is that students never check a match against end behavior. They find two intercepts, take the first card that shows those zeros, and move on.

When a match goes wrong, and it will, the fastest repair is a test point. Pick one or two x-values between the turning points, put them into the equation, and see whether the resulting point lands anywhere near the curve on the graph card. If it lands in the wrong region, the student has caught the error without the answer key.

Teacher checks that reveal guessing

- Ask students to point at the exact intercept that shows each multiplicity. “It touches” is not enough unless they connect touching to even multiplicity.
- Have students predict both tails from degree and leading sign before they look at the graph card.
- For a disputed equation, substitute one easy x-value or compare the y-intercept. That separates two graphs with the same roots faster than anything else.
- Do not require a perfect sketch. The graph cards were generated from the equations; the goal is structural matching, not drawing accuracy.

Catching a wrong match with a test point

TEACHER GUIDE

The repair routine students can run alone

Students almost never check a finished row. They read two intercepts, take a card that shows those zeros, and stop. Two habits fix most of it: read the tails before the intercepts, and test one point between the turns.

Worked example: a leading coefficient that hides

- A student matches the standard-level graph that crosses at $x = -3$ and turns on the axis at $x = 1$ with the factored form $y = (x + 3)(x - 1)^2$. The zeros are right, the multiplicities are right, and the end behavior is right, so nothing looks wrong.
- Test a point. At $x = 0$ their version gives $y = (3)(1) = 3$, but the graph card crosses the y-axis at 6. The shape is correct and the vertical scale is not, so the leading coefficient card is the problem: the function is $y = 2(x + 3)(x - 1)^2$.
- One substitution found an error that zeros, multiplicity, degree, and end behavior all missed. That is the point of the routine.

Where to test

- Between two turning points, never outside the last intercept. Out on the tails every candidate function looks the same.
- At $x = 0$ first when the y-intercept is visible. It is the cheapest check on the page and it catches wrong leading coefficients immediately.
- Just to the left and right of a repeated root when a student cannot decide between a touch and a cross. An even multiplicity keeps the same sign on both sides.

Four wrong matches the distractors are built to catch

Counting intercepts as the degree

The challenge level has a fifth-degree function with two visible x-intercepts. Counting intercepts gives degree 2 and the tails then refuse to agree.

Reading a touch as a cross

Functions inside a level share zeros with different multiplicities. Only the behavior at the intercept separates them.

Using degree alone for the tails

Parity fixes whether the tails match, not which way they point. Every level carries a positive and a negative version of the same degree.

Ignoring vertical scale

Leading coefficients of ± 1, ± 2, and $+1/2$ appear across the set. Without a test point, same-shape graphs look interchangeable.

Introductory - Answer Key

Cut-card codes and uncut option numbers

TEACHER KEY

Each row is one complete function family. The uncut number is the option that matches that graph letter on the no-cut worksheet.

GRAPH	EXPANDED EQUATION	FACTORED FORM	ZEROS	MULTIPLICITY	END BEHAVIOR	DEGREE	LEADING
A G-2	**$y = x^2 + x - 2$** E-1 · uncut 4	**$y = (x + 2)(x - 1)$** F-2 · uncut 1	**{-2, 1}** Z-4 · uncut 4	**x = -2: m = 1** **x = 1: m = 1** M-4 · uncut 2	**left up; right up** B-3 · uncut 1	**2** D-4 uncut 3	**+1** L-2 uncut 4
B G-1	**$y = -x^2 + 2x - 1$** E-4 · uncut 3	**$y = -(x - 1)^2$** F-4 · uncut 3	**{1}** Z-3 · uncut 3	**x = 1: m = 2** M-3 · uncut 3	**left down; right down** B-4 · uncut 4	**2** D-1 uncut 1	**-1** L-3 uncut 2
C G-4	**$y = x^3 - 3x - 2$** E-3 · uncut 1	**$y = (x + 1)^2(x - 2)$** F-3 · uncut 4	**{-1, 2}** Z-2 · uncut 1	**x = -1: m = 2** **x = 2: m = 1** M-2 · uncut 4	**left down; right up** B-1 · uncut 3	**3** D-2 uncut 2	**+1** L-1 uncut 1
D G-3	**$y = -x^3 + 2x^2 + 5x - 6$** E-2 · uncut 2	**$y = -(x + 2)(x - 1)(x - 3)$** F-1 · uncut 2	**{-2, 1, 3}** Z-1 · uncut 2	**x = -2: m = 1** **x = 1: m = 1** **x = 3: m = 1** M-1 · uncut 1	**left up; right down** B-2 · uncut 2	**3** D-3 uncut 4	**-1** L-4 uncut 3

FAST CHECK

Even multiplicity touches and turns; odd multiplicity crosses. Even degree has matching tail directions; odd degree has opposite tails. The leading sign chooses which direction is up.
Still disputed? Substitute one x-value between the turns and compare the point with the graph card.

Standard Algebra 2 - Answer Key

Cut-card codes and uncut option numbers

TEACHER KEY

Each row is one complete function family. The uncut number is the option that matches that graph letter on the no-cut worksheet.

GRAPH	EXPANDED EQUATION	FACTORED FORM	ZEROS	MULTIPLICITY	END BEHAVIOR	DEGREE	LEADING
A G-2	**$y = 2x^3 + 2x^2 - 10x + 6$** E-3 · uncut 3	**$y = 2(x + 3)(x - 1)^2$** F-3 · uncut 3	**{-3, 1}** Z-3 · uncut 3	**x = -3: m = 1** **x = 1: m = 2** M-5 · uncut 5	**left down; right up** B-5 · uncut 5	**3** D-1 uncut 4	**+2** L-5 uncut 4
B G-3	**$y = -x^4 + 8x^2 - 16$** E-2 · uncut 2	**$y = -(x + 2)^2(x - 2)^2$** F-1 · uncut 1	**{-2, 2}** Z-2 · uncut 5	**x = -2: m = 2** **x = 2: m = 2** M-2 · uncut 3	**left down; right down** B-2 · uncut 2	**4** D-4 uncut 5	**-1** L-3 uncut 2
C G-4	**$y = x^4 + x^3 - 3x^2 - 5x - 2$** E-5 · uncut 1	**$y = (x + 1)^3(x - 2)$** F-5 · uncut 5	**{-1, 2}** Z-5 · uncut 2	**x = -1: m = 3** **x = 2: m = 1** M-4 · uncut 2	**left up; right up** B-1 · uncut 3	**4** D-5 uncut 2	**+1** L-4 uncut 1
D G-1	**$y = -2x^3 + 8x$** E-1 · uncut 5	**$y = -2x(x - 2)(x + 2)$** F-4 · uncut 4	**{-2, 0, 2}** Z-1 · uncut 1	**x = -2: m = 1** **x = 0: m = 1** **x = 2: m = 1** M-1 · uncut 1	**left up; right down** B-3 · uncut 1	**3** D-3 uncut 1	**-2** L-2 uncut 5
E G-5	**$y = x^4 - 3x^3 - 7x^2 + 15x + 18$** E-4 · uncut 4	**$y = (x - 3)^2(x + 1)(x + 2)$** F-2 · uncut 2	**{-2, -1, 3}** Z-4 · uncut 4	**x = -2: m = 1** **x = -1: m = 1** **x = 3: m = 2** M-3 · uncut 4	**left up; right up** B-4 · uncut 4	**4** D-2 uncut 3	**+1** L-1 uncut 3

FAST CHECK

Even multiplicity touches and turns; odd multiplicity crosses. Even degree has matching tail directions; odd degree has opposite tails. The leading sign chooses which direction is up.
Still disputed? Substitute one x-value between the turns and compare the point with the graph card.

Challenge - Answer Key

Cut-card codes and uncut option numbers

TEACHER KEY

Each row is one complete function family. The uncut number is the option that matches that graph letter on the no-cut worksheet.

GRAPH	EXPANDED EQUATION	FACTORED FORM	ZEROS	MULTIPLICITY	END BEHAVIOR	DEGREE	LEADING
A G-3	**$y = 0.5x^5 + 2x^4 + 0.5x^3 - 5x^2 - 2x + 4$** E-2 · uncut 4	**$y = 0.5(x + 2)^3(x - 1)^2$** F-3 · uncut 5	**{-2, 1}** Z-4 · uncut 1	**x = -2: m = 3** **x = 1: m = 2** M-2 · uncut 5	**left down; right up** B-1 · uncut 2	**5** D-3 uncut 5	**+1/2** L-1 uncut 2
B G-4	**$y = -x^5 + x^4 + 6x^3 - 14x^2 + 11x - 3$** E-1 · uncut 3	**$y = -(x + 3)(x - 1)^4$** F-5 · uncut 4	**{-3, 1}** Z-5 · uncut 5	**x = -3: m = 1** **x = 1: m = 4** M-4 · uncut 1	**left up; right down** B-3 · uncut 1	**5** D-1 uncut 4	**-1** L-4 uncut 1
C G-2	**$y = 2x^4 - 2x^3 - 4x^2$** E-4 · uncut 5	**$y = 2x^2(x - 2)(x + 1)$** F-1 · uncut 2	**{-1, 0, 2}** Z-2 · uncut 3	**x = -1: m = 1** **x = 0: m = 2** **x = 2: m = 1** M-1 · uncut 3	**left up; right up** B-4 · uncut 4	**4** D-2 uncut 3	**+2** L-5 uncut 4
D G-5	**$y = -x^4 + 9x^2 + 4x - 12$** E-3 · uncut 2	**$y = -(x + 2)^2(x - 1)(x - 3)$** F-2 · uncut 1	**{-2, 1, 3}** Z-1 · uncut 2	**x = -2: m = 2** **x = 1: m = 1** **x = 3: m = 1** M-5 · uncut 2	**left down; right down** B-5 · uncut 5	**4** D-5 uncut 1	**-1** L-3 uncut 5
E G-1	**$y = x^5 - 4x^4 + x^3 + 10x^2 - 4x - 8$** E-5 · uncut 1	**$y = (x + 1)^2(x - 2)^3$** F-4 · uncut 3	**{-1, 2}** Z-3 · uncut 4	**x = -1: m = 2** **x = 2: m = 3** M-3 · uncut 4	**left down; right up** B-2 · uncut 3	**5** D-4 uncut 2	**+1** L-2 uncut 3

FAST CHECK

Even multiplicity touches and turns; odd multiplicity crosses. Even degree has matching tail directions; odd degree has opposite tails. The leading sign chooses which direction is up.
Still disputed? Substitute one x-value between the turns and compare the point with the graph card.

Standards, differentiation, and reuse

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Polynomial graph-matching card sort

Standards and skill map

HSA.APR.B.3	Use zeros to sketch and interpret polynomial graphs.
HSF.IF.C.7c	Graph polynomial functions and identify zeros when suitable factorizations are available.
HSA.SSE.A.2	Use the structure of an expression, including factors and repeated factors.
MP3	Construct a justification and critique a partner's match using graph evidence.

Differentiate without rebuilding the activity

SUPPORT	Remove the expanded-equation cards first. Students match graphs to factored form, zeros, and multiplicity before the other properties are added.
CORE	Use all eight card types. Require one written defense for multiplicity and one for end behavior.
EXTEND	Hide the degree and leading-coefficient cards. Students write those two cards themselves once the rest of the family is assembled.
CHALLENGE	Ask for an estimated y-intercept and the maximum possible number of turning points, then use both as independent checks.

Printing and reuse

- Print at actual size or 100%. Do not use “fit to page” if you want the same card dimensions across several copies.
- Card headers carry color and a text label, so the activity still works on a black-and-white printer.
- Teachers and families may print, copy, and adapt these pages for their own students. Please link to the source page rather than reposting the PDF, so corrections stay attached to the current key.
- This is a classroom-made, criterion-referenced activity, not a standardized assessment. Use the pattern of mismatches and the written explanations to decide what to reteach.

ANSWER-KEY VERIFICATION

All 14 graphs were plotted directly from their coefficient lists. Every expanded form was recomputed from its factors, every zero and multiplicity was re-derived, and each card code and numbered option was confirmed to appear exactly once per level before this file was published.
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