NEXT GENERATION SCIENCE STANDARDS

COMMON CORE CLASSROOM STANDARDS

GRADES 6-8

UPDATED 2026-10-12-04:12AM

Mini 4WD

275 Standards, Point for Point.

The Next Generation Science Standards are used for teaching science and engineering in S.T.E.M. education in California. California has none of its own science or engineering standards.

Common Core Classroom Standards are used for teaching language arts and math in California. California has (35) of its own language arts standards and (1) own math standard. Each state of the US typically has its own standards that sit outside each discipline set.

Each NGSS and CCCS Standard is listed as a card: the standard, then one Mini 4WD aspect.

NGSS (63), CCCS (173), CA (36).

THE DISCIPLINES	QUANTITY
Engineering	4
Language Arts	131
Mathematics	81
Science	59

E.L.M.S. education focuses on Engineering used in forming written Language as including the characters of letters and numbers of Math used in self-reflective forming of Science.
(Elms are symbols of Liberty such as the Liberty Tree (1646) and the Sloop Liberty (1768)).

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How to Read This Book

The Spine

This copy is for grades 6, 7, and 8. The Spine includes the Next Generation Science Standards and Common Core Classroom Standards. A state standard is filed in the grade a teacher would open.

Each card is one standard, then one Mini 4WD aspect. Clarification statements and assessment boundaries stay with the standard. The bronze codes beside the standard name every document that includes it. NG is the Next Generation Science Standards. CC is the Common Core Classroom Standards. Each state has its own code.

The Arrangement

Grades 6 through 8 follow the integrated model.

The middle-school Engineering set is listed under grade 6. A state standard written for a grade band is repeated in each grade of that band.

The Mini 4WD Aspect

Mini 4WD here is a scale-model lane car: chassis, wheels, tires, axles, gears, motor, cells, rollers, body, and a walled track. Where a standard is about a living thing, the weather, or the Earth, the car is the comparison metaphor archetype object in the room. It is not an organism.

A fair test on an Engineering card changes one thing at a time, which is the same discipline that class asks of a race rule.

Language Arts covers (STEAM) as social contracts, trust, etiquette, attitude, and manners.

Mathematics covers the characters of numbers used on the car: counts, ratios, lengths, and times.

Science covers the self-reflective forming of the standard against the car in the room.

Engineering

4 standards

Engineering · Grades 6–8

4 standards

MS-ETS1-1 NG, CA, MI, NJ, PA

Grades 6–8

STANDARD

Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MINI 4WD

Write the lane-stay problem with a measured test, a mass limit, a parts list, and one way the fix could bother the people beside the track or the ground under it. (Source: Cursor)

MS-ETS1-2 NG, CA, MI, NJ, PA

Grades 6–8

STANDARD

Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

MINI 4WD

Score two complete cars against the same written tests: stays in the lane, finishes, stays within the parts you allowed. (Source: Cursor)

MS-ETS1-3 NG, CA, FL, MI, NJ, PA

Grades 6–8

STANDARD

Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

MINI 4WD

From tests of two cars, name one feature of each that you would combine into a third car, and the criterion that third car is supposed to meet. (Source: Cursor)

MS-ETS1-4 NG, CA, FL, MI, NJ, PA

Grades 6-8

STANDARD

Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

MINI 4WD

Make a simple repeatable setup, such as the same slope and the same release, so each change of roller or mass produces a new time you can compare with the last. (Source: Cursor)

Language Arts

131 standards

Language Arts · Grade 6

43 standards

RL.6.1 CC, CA, MI, OH

Grade 6

STANDARD

Cite textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.

MINI 4WD

Quote Ad Finem's sentence "The axle transfers energy from the gear to the wheel." Mark the words that say the transfer outright, then write one inference about which part must turn next, and label the inference as yours. (Source: Ad Finem Liminis)

RL.6.2 CC, CA, MI

Grade 6

STANDARD

Determine a theme or central idea of a text and how it is conveyed through particular details; provide a summary of the text distinct from personal opinions or judgments.

MINI 4WD

The master class states one idea in a kid line and a parent line: govern ourselves so no one has to police the race. Name two details that carry the idea, and summarize the page without saying whether you like the rule. (Source: Mini Manners)

RL.6.3 CC, CA, MI, OH

Grade 6

STANDARD

Describe how a particular story's or drama's plot unfolds in a series of episodes as well as how the characters respond or change as the plot moves toward a resolution.

MINI 4WD

Tell the build as episodes: crown gear on, counter gear in that drive, axle through, motor snapped in, tire seated on the wheel. Say what the builder does after the page says "SNAP!" that the builder was not doing before. (Source: Ad Finem Liminis)

RL.6.4 CC, CA, MI

Grade 6

STANDARD

Determine the meaning of words and phrases as they are used in a text, including figurative and connotative meanings; analyze the impact of a specific word choice on meaning and tone.

MINI 4WD

The brake page prints "BRAKE (break)" over a sentence about friction. Say what "brake" means in that sentence, what "break" is doing in the heading, and how the second spelling changes the tone. (Source: Ad Finem Liminis)

RL.6.5 CC, CA, MI, OH

Grade 6

STANDARD

Analyze how a particular sentence, chapter, scene, or stanza fits into the overall structure of a text and contributes to the development of the theme, setting, or plot.

MINI 4WD

In Step 16, "Turn chassis over" comes before the 2×5 mm screws. Explain what that one line does for the rest of the step, and what the picture would mean if the line were not there. The screwdriver is the tool for those screws. (Source: Ad Finem Liminis)

RL.6.6 CC, CA, MI

Grade 6

STANDARD

Explain how an author develops the point of view of the narrator or speaker in a text.

MINI 4WD

The master class says the same rule once as a kid and once as a parent or coach. Explain how the speaker changes the voice of the rule without changing the rule. (Source: Mini Manners)

RL.6.7 CC, CA, MI, OH

Grade 6

STANDARD

Compare and contrast the experience of reading a story, drama, or poem to listening to or viewing an audio, video, or live version of the text, including contrasting what they "see" and "hear" when reading the text to what they perceive when they listen or watch.

MINI 4WD

Read the axle page, then look at the axle drawn in Step 4. Name one thing the printed sentence gives you that the drawing does not say, and one thing the drawing shows that the sentence does not say. (Source: Ad Finem Liminis)

RL.6.9 CC, CA, MI, OH

Grade 6

STANDARD

Compare and contrast texts in different forms or genres (e.g., stories and poems; historical novels and fantasy stories) in terms of their approaches to similar themes and topics.

MINI 4WD

Set the axle's letter page beside Step 4, which draws the same axle. Say what the letter page does with words, and what the step page does with the picture, about that one part. (Source: Ad Finem Liminis)

RL.6.10 CC, CA, MI

Grade 6

STANDARD

By the end of the year, read and comprehend literature, including stories, dramas, and poems, in the grades 6-8 text complexity band proficiently, with scaffolding as needed at the high end of the range.

MINI 4WD

Read one whole Ad Finem part page, side box included, and retell it. Stay with the page through the end of the box. (Source: Ad Finem Liminis)

RI.6.1 CC, CA, MI, OH

Grade 6

STANDARD

Cite textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.

MINI 4WD

Quote "The bushing / bearing provides stable support for the axle's energy transfer." Write what that sentence says outright, and one inference it does not yet prove about how tight the fit is once a film of grease is on it. (Source: Ad Finem Liminis)

RI.6.2 CC, CA, MI

Grade 6

STANDARD

Determine a central idea of a text and how it is conveyed through particular details; provide a summary of the text distinct from personal opinions or judgments.

MINI 4WD

Take the battery page's first sentence as the central idea: the battery transfers energy from the chemicals it stores to the switch terminals, with the battery latch holding the cells. Give two details that carry it, and summarize the page without judging the cell. (Source: Ad Finem Liminis)

RI.6.3 CC, CA, MI, OH

Grade 6

STANDARD

Analyze in detail how a key individual, event, or idea is introduced, illustrated, and elaborated in a text (e.g., through examples or anecdotes).

MINI 4WD

Follow "bearing" from the job sentence, to "bears weight," to the side box. Say how each stop introduces the idea, then shows it, then adds another layer. (Source: Ad Finem Liminis)

RI.6.4 CC, CA, MI, OH

Grade 6

STANDARD

Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings.

MINI 4WD

On the switch page, give the technical meaning of "switch" at the terminals, and the other meaning the page writes when it says to switch is to change from open to closed. (Source: Ad Finem Liminis)

RI.6.6 CC, CA, MI, PA

Grade 6

STANDARD

Determine an author's point of view or purpose in a text and explain how it is conveyed in the text.

MINI 4WD

The master class leaves slot-car track power out on purpose, because Mini 4WD carries its own internal battery and has no hand controller. State that purpose, and point to the sentence that states it. (Source: Mini Manners)

RI.6.7 CC, CA, MI, PA

Grade 6

STANDARD

Integrate information presented in different media or formats (e.g., visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue.

MINI 4WD

Step 16 gives a picture, the words "Turn chassis over," and the measure 2×5 mm. Use the words and the measure together to say where the brake goes. (Source: Ad Finem Liminis)

RI.6.8 CC, CA, MI

Grade 6

STANDARD

Trace and evaluate the argument and specific claims in a text, distinguishing claims that are supported by reasons and evidence from claims that are not.

MINI 4WD

The master class claims a 9- or 10-tooth pinion moves the gear ratio toward higher top speed where the legal pinion is 8-tooth. Separate that claim from the reason the page gives, and say what is still only a claim. (Source: Mini Manners)

RI.6.9 CC, CA, MI

Grade 6

STANDARD

Compare and contrast one author's presentation of events with that of another (e.g., a memoir written by and a biography on the same person).

MINI 4WD

Read the battery page and the master class sentence that Mini 4WD carries its own internal battery. Say what each text chooses to tell about the same cells. (Source: Ad Finem Liminis, Mini Manners)

RI.6.10 CC, CA, MI

Grade 6

STANDARD

By the end of the year, read and comprehend literary nonfiction in the grades 6-8 text complexity band proficiently, with scaffolding as needed at the high end of the range.

MINI 4WD

Read the master class passage that sets Mini 4WD beside slot cars, and retell the comparison in your own words. (Source: Mini Manners)

W.6.1 CC, CA, MI

Grade 6

STANDARD

Write arguments to support claims with clear reasons and relevant evidence. a. Introduce claim(s) and organize the reasons and evidence clearly. b. Support claim(s) with clear reasons and relevant evidence, using credible sources and demonstrating an understanding of the topic or text. c. Use words, phrases, and clauses to clarify the relationships among claim(s) and reasons. d. Establish and maintain a formal style. e. Provide a concluding statement or section that follows from the argument presented.

MINI 4WD

Write an argument that the car at the line ought to be the car that was inspected. Give two reasons from the master class, keep a formal tone, and close with a sentence that follows from those reasons. (Source: Mini Manners)

W.6.3 CC, CA, MI, NJ, OH

Grade 6

STANDARD

Write narratives to develop real or imagined experiences or events using effective technique, relevant descriptive details, and well-structured event sequences. a. Engage and orient the reader by establishing a context and introducing a narrator and/or characters; organize an event sequence that unfolds naturally and logically. b. Use narrative techniques, such as dialogue, pacing, and description, to develop experiences, events, and/or characters. c. Use a variety of transition words, phrases, and clauses to convey sequence and signal shifts from one time frame or setting to another. d. Use precise words and phrases, relevant descriptive details, and sensory language to convey experiences and events. e. Provide a conclusion that follows from the narrated experiences or events.

MINI 4WD

Write the Step 10 motor install as a narrative: a builder, the line "Attach this end first," the snap, and a closing sentence once the motor is seated under the motor cover. Name the motor. (Source: Ad Finem Liminis)

W.6.4 CC, CA, MI, OH

Grade 6

STANDARD

Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. (Grade-specific expectations for writing types are defined in standards 1-3 above.)

MINI 4WD

Write the brake install as steps for a builder holding the chassis. Then write the same work as one paragraph for a reader who has never seen the car. Fit each version to its reader. (Source: Ad Finem Liminis)

W.6.6 CC, CA, MI

Grade 6

STANDARD

Use technology, including the Internet, to produce and publish writing as well as to interact and collaborate with others; demonstrate sufficient command of keyboarding skills to type a minimum of three pages in a single sitting.

MINI 4WD

Type the axle page's job sentence and your one-sentence inference, and put the note where the other builders can open it. (Source: Ad Finem Liminis)

W.6.7 CC, CA, MI, NJ, OH

Grade 6

STANDARD

Conduct short research projects to answer a question, drawing on several sources and refocusing the inquiry when appropriate.

MINI 4WD

Ask what the bearing does for the axle. Answer from the Ad Finem page. Where the step drawing does not answer, write the new question the drawing forces. (Source: Ad Finem Liminis)

W.6.8 CC, CA, MI, OH

Grade 6

STANDARD

Gather relevant information from multiple print and digital sources; assess the credibility of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and providing basic bibliographic information for sources.

MINI 4WD

Quote the bearing's job sentence and paraphrase the side box. Name both as Ad Finem Liminis, and say that the side box is the book's letter reading, not a measurement you made. (Source: Ad Finem Liminis)

W.6.9 CC, CA, MI, OH

Grade 6

STANDARD

Draw evidence from literary or informational texts to support analysis, reflection, and research. a. Apply grade 6 Reading standards to literature (e.g., "Compare and contrast texts in different forms or genres [e.g., stories and poems; historical novels and fantasy stories] in terms of their approaches to similar themes and topics"). b. Apply grade 6 Reading standards to literary nonfiction (e.g., "Trace and evaluate the argument and specific claims in a text, distinguishing claims that are supported by reasons and evidence from claims that are not").

MINI 4WD

From the axle page, take the sentence about energy moving from the gear to the wheel. From the master class, take the line that the raced car is the inspected car. Use both quotations in one short note. (Source: Ad Finem Liminis, Mini Manners)

W.6.10 CC, CA, MI, OH, PA

Grade 6

STANDARD

Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

MINI 4WD

On one day, write a short note while the crown gear is going on. On another day, rewrite that note after you have reread the page. (Source: Ad Finem Liminis)

SL.6.1 CC, CA, MI, NJ, OH

Grade 6

STANDARD

Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 6 topics, texts, and issues, building on others' ideas and expressing their own clearly. a. Come to discussions prepared, having read or studied required material; explicitly draw on that preparation by referring to evidence on the topic, text, or issue to probe and reflect on ideas under discussion. b. Follow rules for collegial discussions, set specific goals and deadlines, and define individual roles as needed. c. Pose and respond to specific questions with elaboration and detail by making comments that contribute to the topic, text, or issue under discussion. d. Review the key ideas expressed and demonstrate understanding of multiple perspectives through reflection and paraphrasing.

MINI 4WD

Read the switch page before you speak. In the group, point to a sentence, ask one question about open and closed, and restate what another builder said about the terminals and the terminal clip. (Source: Ad Finem Liminis)

SL.6.2 CC, CA, MI, OH, PA

Grade 6

STANDARD

Interpret information presented in diverse media and formats (e.g., visually, quantitatively, orally) and explain how it contributes to a topic, text, or issue under study.

MINI 4WD

Step 4 labels "Crown Gear (pink)" and "Axle" on a drawing. Explain what the drawing adds to the labels, and what the labels add to the drawing. (Source: Ad Finem Liminis)

SL.6.3 CC, CA, MI, OH

Grade 6

STANDARD

Delineate a speaker's argument and specific claims, distinguishing claims that are supported by reasons and evidence from claims that are not.

MINI 4WD

If a speaker says any pinion will do, ask which master class sentence supports that. The page's legal pinion is the 8-tooth. Mark any claim that has no sentence under it. (Source: Mini Manners)

SL.6.5 CC, CA, MI, NJ, OH

Grade 6

STANDARD

Include multimedia components (e.g., graphics, images, music, sound) and visual displays in presentations to clarify information.

MINI 4WD

Show the brake page and Step 16 together. Let the picture carry the 2×5 mm screw and its washer, and let your words carry the claim that the brake increases friction at the tire. (Source: Ad Finem Liminis)

SL.6.6 CC, CA, MI

Grade 6

STANDARD

Adapt speech to a variety of contexts and tasks, demonstrating command of formal English when indicated or appropriate. (See grade 6 Language standards 1 and 3 on page 53 for specific expectations.)

MINI 4WD

Tell a younger builder, in ordinary speech, that the switch joins the two halves of the terminal set, and the terminal clip holds that set. Then say that same fact in the formal line you would use at inspection. (Source: Ad Finem Liminis, Mini Manners)

L.6.2 CC, CA, MI, OH

Grade 6

STANDARD

Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing. a. Use punctuation (commas, parentheses, dashes) to set off nonrestrictive/parenthetical elements.* b. Spell correctly.

MINI 4WD

Copy "The axle transfers energy from the gear to the wheel." Keep its capitals and its period. If you add a part name in parentheses, set it off, and spell crown, counter gear, chassis, and gear shaft as the pages spell them. (Source: Ad Finem Liminis)

L.6.3 CC, CA, MI, OH

Grade 6

STANDARD

Use knowledge of language and its conventions when writing, speaking, reading, or listening. a. Vary sentence patterns for meaning, reader/ listener interest, and style.* b. Maintain consistency in style and tone.*

MINI 4WD

Write one short sentence for the bearing's job and one longer sentence for how the page builds the word. Keep one tone in both, as notes for the build. (Source: Ad Finem Liminis)

L.6.4 CC, CA, MI

Grade 6

STANDARD

Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grade 6 reading and content, choosing flexibly from a range of strategies. a. Use context (e.g., the overall meaning of a sentence or paragraph; a word's position or function in a sentence) as a clue to the meaning of a word or phrase. b. Use common, grade-appropriate Greek or Latin affixes and roots as clues to the meaning of a word (e.g., audience, auditory, audible). c. Consult reference materials (e.g., dictionaries, glossaries, thesauruses), both print and digital, to find the pronunciation of a word or determine or clarify its precise meaning or its part of speech. d. Verify the preliminary determination of the meaning of a word or phrase (e.g., by checking the inferred meaning in context or in a dictionary).

MINI 4WD

On the bearing page, use the sentences around "bushing" as the context clue, then check a glossary. The page's clue is that the part surrounds the axle and bears the load. (Source: Ad Finem Liminis)

L.6.5 CC, CA, MI

Grade 6

STANDARD

Demonstrate understanding of figurative language, word relationships, and nuances in word meanings. a. Interpret figures of speech (e.g., personification) in context. b. Use the relationship between particular words (e.g., cause/effect, part/whole, item/category) to better understand each of the words. c. Distinguish among the connotations (associations) of words with similar denotations (definitions) (e.g., stingy, scrimping, economical, unwasteful, thrifty).

MINI 4WD

The brake page sets "brake" next to "break." Say how the two words are related, and keep the friction sentence's job distinct from the heading's letter reading. (Source: Ad Finem Liminis)

L.6.6 CC, CA, MI, OH

Grade 6

STANDARD

Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases; gather vocabulary knowledge when considering a word or phrase important to comprehension or expression.

MINI 4WD

In one build note, use the terminal clip, counter gear, crown gear, terminal, body latch, and friction for the things the pages name. (Source: Ad Finem Liminis)

L.6.1 CA

Grade 6

STANDARD

Demonstrate command of the conventions of standard English grammar and usage when writing or speaking. a. Ensure that pronouns are in the proper case (subjective, objective, possessive). b. Use all pronouns, including intensive pronouns (e.g., ourselves) correctly. myself, c. Recognize and correct inappropriate shifts in pronoun number and person.* d. Recognize and correct vague pronouns (i.e., ones with unclear or ambiguous antecedents).* e. Recognize variations from standard English in their own and others' writing and speaking, and identify and use strategies to improve expression in conventional language.*

MINI 4WD

Rewrite "The builder fits the axle" so the pronoun is in the right case, and make "it" mean the axle rather than the crown gear. (Source: Ad Finem Liminis)

RI.6.5 CA

Grade 6

STANDARD

Analyze how a particular sentence, paragraph, chapter, or section fits into the overall structure of a text and contributes to the development of the ideas. a. Analyze the use of text features (e.g., graphics, headers, captions) in popular media.

MINI 4WD

On the axle page, say what the header, the job sentence, and the MODEL, TRACE, and DRAW boxes each do, including what a header does that the drawing does not. (Source: Ad Finem Liminis)

RL.6.4 CA

Grade 6

STANDARD

See grade 6 Language standards 4-6 for additional expectations.

MINI 4WD

Read the switch page with the grade 6 language work: what "switch" means in that text, which sense is technical, and which word you confirm in a glossary. (Source: Ad Finem Liminis)

SL.6.4 CA

Grade 6

STANDARD

Present claims and findings (e.g., argument, narrative, informative, response to literature presentations), sequencing ideas logically and using pertinent descriptions, facts, and details and nonverbal elements to accentuate main ideas or themes; use appropriate eye contact, adequate volume, and clear pronunciation. a. Plan and deliver an informative/explanatory presentation that: develops a topic with relevant facts, definitions, and concrete details; uses appropriate transitions to clarify relationships; uses precise language and domain specific vocabulary; and provides a strong conclusion.

MINI 4WD

Present the bearing in order: the job sentence, one detail, how the page builds the word, and a closing line that returns to the job. Speak so the counter gear and the axle can be heard. (Source: Ad Finem Liminis)

SL.6.6 CA

Grade 6

STANDARD

See grade 6 Language standards 1 and 3 for specific expectations.

MINI 4WD

When you explain the switch, keep each pronoun pointed at the part you mean, and keep the same tone from the first sentence to the last. (Source: Ad Finem Liminis)

W.6.2 CA

Grade 6

STANDARD

Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. a. Introduce a topic or thesis statement; organize ideas, concepts, and information, using strategies such as definition, classification, comparison/contrast, and cause/effect; include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension. b. Develop the topic with relevant facts, definitions, concrete details, quotations, or other information and examples. c. Use appropriate transitions to clarify the relationships among ideas and concepts. d. Use precise language and domain-specific vocabulary to inform about or explain the topic. e. Establish and maintain a formal style. f. Provide a concluding statement or section that follows from the information or explanation presented.

MINI 4WD

Explain how the battery reaches the switch terminals. Open with that path, add one detail from the page, use the word terminal, name the terminal foam behind the metal, and close with what the switch can do once the path is there. (Source: Ad Finem Liminis)

W.6.5 CA, OH

Grade 6

STANDARD

With some guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach. (Editing for conventions should demonstrate command of Language standards 1-3 up to and including grade 6.)

MINI 4WD

Draft a Step 16 note, then revise it until another builder can follow "Turn chassis over" and the 2×5 mm screws without asking where to start. (Source: Ad Finem Liminis)

Language Arts · Grade 7

44 standards

RL.7.1 CC, CA, MI, OH

Grade 7

STANDARD

Cite several pieces of textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.

MINI 4WD

Cite several sentences from the axle page, not one, for what the page says outright about the axle, and mark any line you add about the next part as an inference. (Source: Ad Finem Liminis)

RL.7.2 CC, CA, MI, PA

Grade 7

STANDARD

Determine a theme or central idea of a text and analyze its development over the course of the text; provide an objective summary of the text.

MINI 4WD

Follow the master class idea "govern ourselves" from the opening lines through a later entry, such as the inspected car being the raced car. Summarize that development without praising or blaming a builder. (Source: Mini Manners)

RL.7.3 CC, CA, MI, OH

Grade 7

STANDARD

Analyze how particular elements of a story or drama interact (e.g., how setting shapes the characters or plot).

MINI 4WD

The wall is the setting. Show how that setting pushes the brake into the build: the brake page says it increases friction at the tire so the car does not leave the lane. Say how the part and the wall change what the builder does next. (Source: Ad Finem Liminis)

RL.7.4 CC, CA, MI

Grade 7

STANDARD

Determine the meaning of words and phrases as they are used in a text, including figurative and connotative meanings; analyze the impact of rhymes and other repetitions of sounds (e.g., alliteration) on a specific verse or stanza of a poem or section of a story or drama.

MINI 4WD

On the bearing page, track the repeated sounds in bear, ring, and bearing. Say what that repetition does to the meaning of the part's name in those lines. (Source: Ad Finem Liminis)

RL.7.5 CC, CA, MI, OH

Grade 7

STANDARD

Analyze how a drama's or poem's form or structure (e.g., soliloquy, sonnet) contributes to its meaning.

MINI 4WD

The side box sits beside the job sentence the way an aside sits beside the action. Explain how that box form changes what the bearing page means, compared with the job sentence alone. (Source: Ad Finem Liminis)

RL.7.6 CC, CA, MI, PA

Grade 7

STANDARD

Analyze how an author develops and contrasts the points of view of different characters or narrators in a text.

MINI 4WD

The master class develops a kid speaker and a parent speaker across one entry. Contrast the two points of view, and say what each speaker can admit that the other does not. (Source: Mini Manners)

RL.7.7 CC, CA, MI, OH

Grade 7

STANDARD

Compare and contrast a written story, drama, or poem to its audio, filmed, staged, or multimedia version, analyzing the effects of techniques unique to each medium (e.g., lighting, sound, color, or camera focus and angles in a film).

MINI 4WD

Read the sentences for the motor cover, then look at Step 10, with its arrow, the star note "Attach this end first," and "SNAP!" Say what those drawing techniques do that the prose page does not. (Source: Ad Finem Liminis)

RL.7.9 CC, CA, MI, OH, PA

Grade 7

STANDARD

Compare and contrast a fictional portrayal of a time, place, or character and a historical account of the same period as a means of understanding how authors of fiction use or alter history.

MINI 4WD

Write a short fictional heat in which a builder picks a lane. Set it beside the master class account of lane choice on a 3-lane track and a 5-lane track. Say what the fiction changes from that account. (Source: Mini Manners)

RL.7.10 CC, CA, MI

Grade 7

STANDARD

By the end of the year, read and comprehend literature, including stories, dramas, and poems, in the grades 6-8 text complexity band proficiently, with scaffolding as needed at the high end of the range.

MINI 4WD

Read two full Ad Finem part pages in one sitting, side boxes included, and retell both without the pages in front of you. (Source: Ad Finem Liminis)

RI.7.1 CC, CA, MI, OH

Grade 7

STANDARD

Cite several pieces of textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.

MINI 4WD

Cite several sentences, not one, from the battery page for how energy is said to move, and label anything you add about a race result as an inference. (Source: Ad Finem Liminis)

RI.7.2 CC, CA, MI, PA

Grade 7

STANDARD

Determine two or more central ideas in a text and analyze their development over the course of the text; provide an objective summary of the text.

MINI 4WD

The battery page carries two ideas: a job sentence about chemicals and terminals, and a side box about the word "battery." Follow both across the page, and summarize them without taking a side. (Source: Ad Finem Liminis)

RI.7.3 CC, CA, MI, OH

Grade 7

STANDARD

Analyze the interactions between individuals, events, and ideas in a text (e.g., how ideas influence individuals or events, or how individuals influence ideas or events).

MINI 4WD

Show how the master class idea of a written rule changes what a builder does at inspection, and how a builder's choice at inspection changes whether the rule still holds. Use the line that the raced car is the inspected car. (Source: Mini Manners)

RI.7.4 CC, CA, MI, OH

Grade 7

STANDARD

Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze the impact of a specific word choice on meaning and tone.

MINI 4WD

On the switch page, take one word the page leans on, such as "closed" or "open." Say the technical meaning at the terminals, and how that word choice sets the tone of the job sentence. (Source: Ad Finem Liminis)

RI.7.6 CC, CA, MI, PA

Grade 7

STANDARD

Determine an author's point of view or purpose in a text and analyze how the author distinguishes his or her position from that of others.

MINI 4WD

The master class takes a position against treating Mini 4WD as a slot car. Point to the sentence about the car's own battery, and say how that position is marked off from the slot-car rules it refuses. (Source: Mini Manners)

RI.7.7 CC, CA, MI, PA

Grade 7

STANDARD

Compare and contrast a text to an audio, video, or multimedia version of the text, analyzing each medium's portrayal of the subject (e.g., how the delivery of a speech affects the impact of the words).

MINI 4WD

Read Step 16's words, then describe the same step aloud from the drawing only. Compare what the spoken version does to the brake with what the printed lines do. (Source: Ad Finem Liminis)

RI.7.8 CC, CA, MI

Grade 7

STANDARD

Trace and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient to support the claims.

MINI 4WD

Take the master class claim that more pinion teeth move the car toward higher top speed. Judge whether the reason given is sound, and whether the 8-tooth rule is enough evidence for a pinion you have not counted. (Source: Mini Manners)

RI.7.9 CC, CA, MI

Grade 7

STANDARD

Analyze how two or more authors writing about the same topic shape their presentations of key information by emphasizing different evidence or advancing different interpretations of facts.

MINI 4WD

The battery page emphasizes the path from chemicals to terminals. The master class emphasizes that the battery is held by the battery latch. Say which evidence each text pushes forward about the same cells. (Source: Ad Finem Liminis, Mini Manners)

RI.7.10 CC, CA, MI

Grade 7

STANDARD

By the end of the year, read and comprehend literary nonfiction in the grades 6-8 text complexity band proficiently, with scaffolding as needed at the high end of the range.

MINI 4WD

Read a full master class entry, from the move through the parent lesson, and retell the argument without the page. (Source: Mini Manners)

W.7.3 CC, CA, MI, NJ, OH

Grade 7

STANDARD

Write narratives to develop real or imagined experiences or events using effective technique, relevant descriptive details, and well-structured event sequences. a. Engage and orient the reader by establishing a context and point of view and introducing a narrator and/or characters; organize an event sequence that unfolds naturally and logically. b. Use narrative techniques, such as dialogue, pacing, and description, to develop experiences, events, and/or characters. c. Use a variety of transition words, phrases, and clauses to convey sequence and signal shifts from one time frame or setting to another. d. Use precise words and phrases, relevant descriptive details, and sensory language to capture the action and convey experiences and events. e. Provide a conclusion that follows from and reflects on the narrated experiences or events.

MINI 4WD

Narrate one heat from a point of view on the rail: the launch, the cross-over, the tire meeting the track, and a closing line that looks back at the choice of lane. There is no hand on a controller during the run. (Source: Ad Finem Liminis, Mini Manners)

W.7.4 CC, CA, MI, OH

Grade 7

STANDARD

Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. (Grade-specific expectations for writing types are defined in standards 1-3 above.)

MINI 4WD

Write the crown-gear step once as build instructions and once as a report for someone who will inspect the car. Keep each piece organized for that reader. (Source: Ad Finem Liminis, Mini Manners)

W.7.6 CC, CA, MI, OH, PA

Grade 7

STANDARD

Use technology, including the Internet, to produce and publish writing and link to and cite sources as well as to interact and collaborate with others, including linking to and citing sources.

MINI 4WD

Publish a short note on the bearing, and link or cite Ad Finem Liminis and the master class page you used so a reader can open those sources. (Source: Ad Finem Liminis, Mini Manners)

W.7.7 CC, CA, MI, NJ, OH, PA

Grade 7

STANDARD

Conduct short research projects to answer a question, drawing on several sources and generating additional related, focused questions for further research and investigation.

MINI 4WD

Start with one question about why the legal pinion in the master class is 8-tooth. Answer from that page, then write the next question the answer opens, such as what a tooth count does to the ratio. (Source: Mini Manners)

W.7.8 CC, CA, MI, OH

Grade 7

STANDARD

Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.

MINI 4WD

Search the master class for "8-tooth" and the Ad Finem pages for "axle." Quote one line from each, paraphrase a third, and cite both sources in one format you keep steady. (Source: Ad Finem Liminis, Mini Manners)

W.7.9 CC, CA, MI, OH

Grade 7

STANDARD

Draw evidence from literary or informational texts to support analysis, reflection, and research. a. Apply grade 7 Reading standards to literature (e.g., "Compare and contrast a fictional portrayal of a time, place, or character and a historical account of the same period as a means of understanding how authors of fiction use or alter history"). b. Apply grade 7 Reading standards to literary nonfiction (e.g. "Trace and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient to support the claims").

MINI 4WD

Use the fictional heat you can write, and the master class account of the same kind of lane choice, as your two texts. Draw one piece of evidence from each for a note on what the fiction altered. (Source: Mini Manners)

W.7.10 CC, CA, MI, OH

Grade 7

STANDARD

Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

MINI 4WD

Across two days, keep a build log: a long note after a full step, and a short note in the minute after the motor snaps in. (Source: Ad Finem Liminis)

SL.7.2 CC, CA, MI, OH

Grade 7

STANDARD

Analyze the main ideas and supporting details presented in diverse media and formats (e.g., visually, quantitatively, orally) and explain how the ideas clarify a topic, text, or issue under study.

MINI 4WD

From Step 4, state the main idea of the drawing and two supporting details, one of them the pink crown gear and one of them the counter gear. Say how those details clarify the step. (Source: Ad Finem Liminis)

SL.7.5 CC, CA, MI, NJ, OH, PA

Grade 7

STANDARD

Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points.

MINI 4WD

In a presentation on the brake, put the Step 16 drawing where the audience can see the 2×5 mm screws, and let that display carry the point your words are making about friction. (Source: Ad Finem Liminis)

SL.7.6 CC, CA, MI

Grade 7

STANDARD

Adapt speech to a variety of contexts and tasks, demonstrating command of formal English when indicated or appropriate. (See grade 7 Language standards 1 and 3 on page 53 for specific expectations.)

MINI 4WD

Explain the switch once to a new builder and once to an inspector. Change the formality. Do not change the fact that the switch contacts the two halves of the terminal set. (Source: Ad Finem Liminis, Mini Manners)

L.7.1 CC, CA, MI, OH

Grade 7

STANDARD

Demonstrate command of the conventions of standard English grammar and usage when writing or speaking. a. Explain the function of phrases and clauses in general and their function in specific sentences. b. Choose among simple, compound, complex, and compound-complex sentences to signal differing relationships among ideas. c. Place phrases and clauses within a sentence, recognizing and correcting misplaced and dangling modifiers.*

MINI 4WD

Combine "The brake increases friction" and "The chassis is turned over" into one sentence with a clause. Then fix any modifier that points at the wrong part, such as a phrase that seems to modify the screw instead of the brake. (Source: Ad Finem Liminis)

L.7.2 CC, CA, MI, OH

Grade 7

STANDARD

Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing. a. Use a comma to separate coordinate adjectives (e.g., It was a fascinating, enjoyable movie but not He wore an old[,] green shirt). b. Spell correctly.

MINI 4WD

Write "a small, pink crown gear" with the comma the coordinate adjectives need, and spell chassis, counter gear, and axle as the pages spell them. Do not put a comma where the adjectives do not coordinate, as in the 2×5 mm screw. (Source: Ad Finem Liminis)

L.7.3 CC, CA, MI

Grade 7

STANDARD

Use knowledge of language and its conventions when writing, speaking, reading, or listening. a. Choose language that expresses ideas precisely and concisely, recognizing and eliminating wordiness and redundancy.*

MINI 4WD

Take a wordy line about the brake and cut it until it says, once, that the brake increases friction at the tire. Drop the repeated words. (Source: Ad Finem Liminis)

L.7.5 CC, CA, MI, OH

Grade 7

STANDARD

Demonstrate understanding of figurative language, word relationships, and nuances in word meanings. a. Interpret figures of speech (e.g., literary, biblical, and mythological allusions) in context. b. Use the relationship between particular words (e.g., synonym/antonym, analogy) to better understand each of the words. c. Distinguish among the connotations (associations) of words with similar denotations (definitions) (e.g., refined, respectful, polite, diplomatic, condescending).

MINI 4WD

The master class calls the same conduct fair, strict, and polite in different lines. Say what those words share, and how "strict" and "polite" pull a rule in different directions. (Source: Mini Manners)

L.7.6 CC, CA, MI, OH

Grade 7

STANDARD

Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases; gather vocabulary knowledge when considering a word or phrase important to comprehension or expression.

MINI 4WD

In a note on one step, use ratio, inspection, terminal, and friction as the master class and Ad Finem use them, not as loose praise. (Source: Ad Finem Liminis, Mini Manners)

L.7.4 CA

Grade 7

STANDARD

Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grade 7 reading and content, choosing flexibly from a range of strategies. a. Use context (e.g., the overall meaning of a sentence or paragraph; a word's position or function in a sentence) as a clue to the meaning of a word or phrase. b. Use common, grade-appropriate Greek or Latin affixes and roots as clues to the meaning of a word (e.g., belligerent, bellicose, rebel). c. Consult general and specialized reference materials (e.g., dictionaries, glossaries, thesauruses), both print and digital, to find the pronunciation of a word or determine or clarify its precise meaning or its part of speech or trace the etymology of words. d. Verify the preliminary determination of the meaning of a word or phrase (e.g., by checking the inferred meaning in context or in a dictionary).

MINI 4WD

On the bearing page, use context for "bushing," a root or affix you can see in the word, and a glossary. Then check your guess against the job sentence. (Source: Ad Finem Liminis)

RI.7.4 CA

Grade 7

STANDARD

See grade 7 Language meaning and tone. standards 4-6 for additional expectations.

MINI 4WD

Apply the grade 7 language work to the switch page: technical meaning, tone of one word choice, and a confirmation in a reference when the page is not enough. (Source: Ad Finem Liminis)

RI.7.5 CA

Grade 7

STANDARD

Analyze the structure an author uses to organize a text, including how the major sections contribute to the whole and to the development of the ideas. a. Analyze the use of text features (e.g., graphics, headers, captions) in public documents.

MINI 4WD

Treat one master class entry as a public document. Say how its header, its move, and its parent lesson each build the whole, and what a header does that the paragraph does not. (Source: Mini Manners)

RL.7.4 CA

Grade 7

STANDARD

See grade 7 Language standards 4-6 for additional expectations.

MINI 4WD

Read the bearing page's repetitions with the grade 7 language work: what bear and ring are doing, and how that sound pattern changes the tone of the name. (Source: Ad Finem Liminis)

SL.7.1 CA

Grade 7

STANDARD

Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 7 building on others' topics, texts, and issues, ideas and expressing their own clearly. a. Come to discussions prepared, having read or researched material under study; explicitly draw on that preparation by referring to evidence on the topic, text, or issue to probe and reflect on ideas under discussion. b. Follow rules for collegial discussions, track progress toward specific goals and dead lines, and define individual roles as needed. c. Pose questions that elicit elaboration and respond to others' questions and comments with relevant observations and ideas that bring the discussion back on topic as needed. d. Acknowledge new information expressed by others and, when warranted, modify their own views.

MINI 4WD

Come to the discussion having read the brake page. Cite a sentence, ask a question that makes someone elaborate, and change your own account if a new fact about Step 16 requires it. (Source: Ad Finem Liminis)

SL.7.3 CA

Grade 7

STANDARD

Delineate a speaker's argument and specific claims, and attitude toward the subject, evaluating the soundness of the reasoning and the relevance and sufficiency of the evidence.

MINI 4WD

Listen to a claim that lane choice does not matter. Judge the reasoning against the master class account of the 3-lane cross-over and the 5-lane corners, and say whether the evidence is enough. (Source: Mini Manners)

SL.7.4 CA

Grade 7

STANDARD

Present claims and findings (e.g., argument, narrative, summary presentations), emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details, and examples; use appropriate eye contact, adequate volume, and clear pronunciation. a. Plan and present an argument that: supports a claim, acknowledges counterarguments, organizes evidence logically, uses words and phrases to create cohesion, and provides a concluding statement that supports the argument presented.

MINI 4WD

Present an argument that the raced car should be the inspected car. Name the opposing claim, order the master class evidence, and end on a sentence that supports your claim. Keep eye contact and say the part names clearly. (Source: Mini Manners)

SL.7.6 CA

Grade 7

STANDARD

See grade 7 Language standards 1 and 3 for specific expectations.

MINI 4WD

In that argument, keep clauses attached to the right part, and do not let a modifier dangle onto the screw or the lane. (Source: Ad Finem Liminis, Mini Manners)

W.7.1 CA

Grade 7

STANDARD

Write arguments to support claims with clear reasons and relevant evidence. a. Introduce claim(s), acknowledge and address alternate or opposing claims, and organize the reasons and evidence logically. b. Support claim(s) or counterarguments with logical reasoning and relevant evidence, using accurate, credible sources and demonstrating an understanding of the topic or text. c. Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), reasons, and evidence. d. Establish and maintain a formal style. e. Provide a concluding statement or section that follows from and supports the argument presented.

MINI 4WD

Argue that an 8-tooth pinion is the legal pinion in the master class account. Acknowledge the opposing claim that any pinion is fine, answer it, and close from the evidence rather than from a slogan. (Source: Mini Manners)

W.7.2 CA

Grade 7

STANDARD

Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. a. Introduce a topic or thesis statement clearly, previewing what is to follow; organize ideas, concepts, and information, using strategies such as definition, classification, comparison/ contrast, and cause/effect; include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension. b. Develop the topic with relevant facts, definitions, concrete details, quotations, or other information and examples. c. Use appropriate transitions to create cohesion and clarify the relationships among ideas and concepts. d. Use precise language and domain-specific vocabulary to inform about or explain the topic. e. Establish and maintain a formal style. f. Provide a concluding statement or section that follows from and supports the information or explanation presented.

MINI 4WD

Explain the path from the battery latch to the switch terminals. Preview the path, include one small diagram or the Step 10 labels if they help, use terminal and switch precisely, and close on what the switch then does. (Source: Ad Finem Liminis)

W.7.5 CA, OH

Grade 7

STANDARD

With some guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on how well purpose and audience have been addressed. (Editing for conventions should demonstrate command of Language standards 1-3 up to and including grade 7.)

MINI 4WD

Revise a heat narrative until the purpose is clear to a reader who was not on the rail, and until the lane, the cross-over, and the tire are in an order that reader can follow. (Source: Ad Finem Liminis, Mini Manners)

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RL.8.1 CC, CA, MI, OH

Grade 8

STANDARD

Cite the textual evidence that most strongly supports an analysis of what the text says explicitly as well as inferences drawn from the text.

MINI 4WD

From the axle page, choose the one sentence that most strongly supports what you say the page means, and then add the inference in a separate clause so the two are not mixed. (Source: Ad Finem Liminis)

RL.8.2 CC, CA, MI, PA

Grade 8

STANDARD

Determine a theme or central idea of a text and analyze its development over the course of the text, including its relationship to the characters, setting, and plot; provide an objective summary of the text.

MINI 4WD

Follow a theme of trust across the master class, and say how it meets the people, the inspection table, and the lane. Summarize that course without cheering for a side. (Source: Mini Manners)

RL.8.3 CC, CA, MI, PA

Grade 8

STANDARD

Analyze how particular lines of dialogue or incidents in a story or drama propel the action, reveal aspects of a character, or provoke a decision.

MINI 4WD

Take one line of talk at the inspection table, or one incident such as the motor's "SNAP!" Show how that line or incident pushes the next action, shows the builder, or forces a decision. (Source: Ad Finem Liminis, Mini Manners)

RL.8.4 CC, CA, MI

Grade 8

STANDARD

Determine the meaning of words and phrases as they are used in a text, including figurative and connotative meanings; analyze the impact of specific word choices on meaning and tone, including analogies or allusions to other texts.

MINI 4WD

On the brake page, weigh "brake" and "break." Say how that word choice sets the tone, and what the pair alludes to if you also hear "break" as a pause in the car's momentum. (Source: Ad Finem Liminis)

RL.8.5 CC, CA, MI, OH, PA

Grade 8

STANDARD

Compare and contrast the structure of two or more texts and analyze how the differing structure of each text contributes to its meaning and style.

MINI 4WD

Compare the structure of an Ad Finem part page with the structure of a master class entry. Say how each structure gives a different meaning to the same car. (Source: Ad Finem Liminis, Mini Manners)

RL.8.7 CC, CA, MI, OH

Grade 8

STANDARD

Analyze the extent to which a filmed or live production of a story or drama stays faithful to or departs from the text or script, evaluating the choices made by the director or actors.

MINI 4WD

Set Step 10 beside the sentences you would write for that motor cover. Judge where the drawing stays with those sentences and where the arrows and "SNAP!" depart from them. (Source: Ad Finem Liminis)

RL.8.9 CC, CA, MI

Grade 8

STANDARD

Analyze how a modern work of fiction draws on themes, patterns of events, or character types from myths, traditional stories, or religious works such as the Bible, including describing how the material is rendered new.

MINI 4WD

The master class opens from an old idea: govern ourselves so others need not. Show how a later entry, the inspected car being the raced car, takes that idea up and makes it a rule at the table. (Source: Mini Manners)

RI.8.1 CC, CA, MI, OH

Grade 8

STANDARD

Cite the textual evidence that most strongly supports an analysis of what the text says explicitly as well as inferences drawn from the text.

MINI 4WD

Pick the single master class sentence that most strongly supports a claim about the car's own battery. Put the inference after it, not inside it. (Source: Mini Manners)

RI.8.2 CC, CA, MI, PA

Grade 8

STANDARD

Determine a central idea of a text and analyze its development over the course of the text, including its relationship to supporting ideas; provide an objective summary of the text.

MINI 4WD

State a central idea of the battery page and show how the side box is related to it, rather than a second topic with no tie. Summarize the page without a verdict on the cell. (Source: Ad Finem Liminis)

RI.8.3 CC, CA, MI

Grade 8

STANDARD

Analyze how a text makes connections among and distinctions between individuals, ideas, or events (e.g., through comparisons, analogies, or categories).

MINI 4WD

The master class connects a pinion's tooth count, a gear ratio, and a top speed, and it also distinguishes an 8-tooth pinion from a 9- or 10-tooth one. Trace one connection and one distinction. (Source: Mini Manners)

RI.8.4 CC, CA, MI, OH

Grade 8

STANDARD

Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze the impact of specific word choices on meaning and tone, including analogies or allusions to other texts.

MINI 4WD

Choose one word on the switch page and one word on the bearing page. Say the technical meaning of each, and how each word's choice changes the tone of its job sentence. Note any allusion the bearing page makes by building bear and ring into the name. (Source: Ad Finem Liminis)

RI.8.7 CC, CA, MI, PA

Grade 8

STANDARD

Evaluate the advantages and disadvantages of using different mediums (e.g., print or digital text, video, multimedia) to present a particular topic or idea.

MINI 4WD

For the brake install, compare the printed step, the drawing, and a spoken demo. Give one advantage and one disadvantage of each medium for getting the 2×5 mm screws in the right place. (Source: Ad Finem Liminis)

RI.8.8 CC, CA, MI, OH

Grade 8

STANDARD

Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient; recognize when irrelevant evidence is introduced.

MINI 4WD

Evaluate the claim that lane choice matters. Use the master class evidence about the 3-lane cross-over and the 5-lane corners, and flag any detail that does not bear on that claim. (Source: Mini Manners)

RI.8.9 CC, CA, MI

Grade 8

STANDARD

Analyze a case in which two or more texts provide conflicting information on the same topic and identify where the texts disagree on matters of fact or interpretation.

MINI 4WD

Set the battery page's energy path beside the master class line that the battery is inside the car. Where they disagree is not a fact of chemistry so much as a choice of what to explain. Say where the two texts part. (Source: Ad Finem Liminis, Mini Manners)

W.8.4 CC, CA, MI, OH

Grade 8

STANDARD

Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. (Grade-specific expectations for writing types are defined in standards 1-3 above.)

MINI 4WD

Write one coherent inspection note: the car on the table is the car that will race, the counter gear you checked, and the brake you saw. Fit the length and the tone to an inspector. (Source: Ad Finem Liminis, Mini Manners)

W.8.6 CC, CA, MI, PA

Grade 8

STANDARD

Use technology, including the Internet, to produce and publish writing and present the relationships between information and ideas efficiently as well as to interact and collaborate with others.

MINI 4WD

Publish a page that shows the relation between the axle sentence and the Step 4 drawing, with a link or a citation to each source, so another builder can move from your note to the pages. (Source: Ad Finem Liminis)

W.8.7 CC, CA, MI, NJ, OH

Grade 8

STANDARD

Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

MINI 4WD

Ask your own question about the crown gear and the counter gear. Answer it from Ad Finem and from the master class, then write two further questions that open different paths, one about ratio and one about inspection. (Source: Ad Finem Liminis, Mini Manners)

W.8.9 CC, CA, MI

Grade 8

STANDARD

Draw evidence from literary or informational texts to support analysis, reflection, and research. a. Apply grade 8 Reading standards to literature (e.g., "Analyze how a modern work of fiction draws on themes, patterns of events, or character types from myths, traditional stories, or religious works such as the Bible, including describing how the material is rendered new"). b. Apply grade 8 Reading standards to literary nonfiction (e.g., "Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient; recognize when irrelevant evidence is introduced").

MINI 4WD

Draw evidence from a story of a heat and from the master class account of lane choice. For the account, test whether the reasoning is sound and whether any vivid detail is beside the point. (Source: Mini Manners)

SL.8.1 CC, CA, MI, NJ, OH

Grade 8

STANDARD

Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly. a. Come to discussions prepared, having read or researched material under study; explicitly draw on that preparation by referring to evidence on the topic, text, or issue to probe and reflect on ideas under discussion. b. Follow rules for collegial discussions and decision-making, track progress toward specific goals and deadlines, and define individual roles as needed. c. Pose questions that connect the ideas of several speakers and respond to others' questions and comments with relevant evidence, observations, and ideas. d. Acknowledge new information expressed by others, and, when warranted, qualify or justify their own views in light of the evidence presented.

MINI 4WD

In a group, connect one speaker's point about the brake to another's point about the wall. Ask a question that ties those ideas, and change or qualify your own view if the Step 16 drawing requires it. (Source: Ad Finem Liminis)

SL.8.2 CC, CA, MI, OH

Grade 8

STANDARD

Analyze the purpose of information presented in diverse media and formats (e.g., visually, quantitatively, orally) and evaluate the motives (e.g., social, commercial, political) behind its presentation.

MINI 4WD

Look at a box of cells and at the Ad Finem battery page. Analyze what each presentation is for, and what motive sits under it: teaching the path of energy, or selling a cell. Say which clues you used. (Source: Ad Finem Liminis)

SL.8.5 CC, CA, MI, NJ, OH

Grade 8

STANDARD

Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest.

MINI 4WD

Build a presentation in which the Step 4 drawing, a counted tooth ratio, and your claim about the counter gear all work together. The display should strengthen the claim, not decorate it. (Source: Ad Finem Liminis, Mini Manners)

L.8.1 CC, CA, MI, OH

Grade 8

STANDARD

Demonstrate command of the conventions of standard English grammar and usage when writing or speaking. a. Explain the function of verbals (gerunds, participles, infinitives) in general and their function in particular sentences. b. Form and use verbs in the active and passive voice. c. Form and use verbs in the indicative, imperative, interrogative, conditional, and subjunctive mood. d. Recognize and correct inappropriate shifts in verb voice and mood.*

MINI 4WD

In a note on the brake, use one verbal such as "turning the chassis over," one passive such as "the screw is seated," and one shift you then correct so the voice does not jump without a reason. (Source: Ad Finem Liminis)

L.8.3 CC, CA, MI

Grade 8

STANDARD

Use knowledge of language and its conventions when writing, speaking, reading, or listening. a. Use verbs in the active and passive voice and in the conditional and subjunctive mood to achieve particular effects (e.g., emphasizing the actor or the action; expressing uncertainty or describing a state contrary to fact).

MINI 4WD

Write "the builder seats the motor" and "the motor is seated" and say which one puts the builder in the sentence and which one puts the action there. Use the pair on purpose in a Step 10 note. (Source: Ad Finem Liminis)

L.8.5 CC, CA, MI, OH

Grade 8

STANDARD

Demonstrate understanding of figurative language, word relationships, and nuances in word meanings. a. Interpret figures of speech (e.g. verbal irony, puns) in context. b. Use the relationship between particular words to better understand each of the words. c. Distinguish among the connotations (associations) of words with similar denotations (definitions) (e.g., bullheaded, willful, firm, persistent, resolute).

MINI 4WD

If a builder says the car "flew" off the lane, say what that figure means for the tire, and how "flew" differs in tone from "left the lane." A pun on "break" and "brake" can be named as a pun, and then set aside so the friction sentence stays clear. (Source: Ad Finem Liminis)

L.8.2 CA

Grade 8

STANDARD

Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing. a. Use punctuation (comma, ellipsis, dash) to indicate a pause or break. b. Use an ellipsis to indicate an omission. c. Spell correctly. 71 English Language Arts 6-12 |

MINI 4WD

Write a sentence that pauses with a dash or an ellipsis where a builder actually waits, such as before "SNAP!" Spell chassis, counter gear, and axle correctly, and use an ellipsis only where you omit words from a quotation. (Source: Ad Finem Liminis)

L.8.4 CA

Grade 8

STANDARD

Determine or clarify the meaning of unknown and multiple-meaning words or phrases based on grade 8 reading and content, choosing flexibly from a range of strategies. a. Use context (e.g., the overall meaning of a sentence or paragraph; a word's position or function in a sentence) as a clue to the meaning of a word or phrase. b. Use common, grade-appropriate Greek or Latin affixes and roots as clues to the meaning of a word (e.g., precede, recede, secede). c. Consult general and specialized reference materials (e.g., dictionaries, glossaries, thesauruses), both print and digital, to find the pronunciation of a word or determine or clarify its precise meaning or its part of speech or trace the etymology of words. d. Verify the preliminary determination of the meaning of a word or phrase (e.g., by checking the inferred meaning in context or in a dictionary). 72 English Language Arts 6-12 |

MINI 4WD

On the bearing page, use context, a word root you can see, and a glossary. Verify the meaning against the job sentence before you treat the side box as the definition. (Source: Ad Finem Liminis)

L.8.6 CA

Grade 8

STANDARD

Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases; gather vocabulary knowledge when considering a word or phrase important to comprehension or expression. 73 English Language Arts 6-12 |

MINI 4WD

Use inspection, ratio, terminal, friction, and cross-over in a note, each for the thing the master class or Ad Finem uses it for. (Source: Ad Finem Liminis, Mini Manners)

RI.8.10 CA

Grade 8

STANDARD

By the end of the year, read and comprehend literary nonfiction at the high end of the grades 6-8 text complexity band independently and proficiently. 52 English Language Arts 6-12 |

MINI 4WD

Read a full master class entry on your own, including the part that says why a rule is kept, and restate the argument without help. (Source: Mini Manners)

RI.8.4 CA

Grade 8

STANDARD

See grade 8 Language or allusions to other texts. standards 4-6 for additional expectations.

MINI 4WD

On the wheel page, FALL is printed beside AUTUMN. Say what each word means there, which sense belongs to the wheel, and what the other sense alludes to. Confirm one of the two in a glossary. (Source: Ad Finem Liminis)

RI.8.5 CA

Grade 8

STANDARD

Analyze in detail the structure of a specific paragraph in a text, including the role of particular sentences in developing and refining a key concept. a. Analyze the use of text features (e.g., graphics, headers, captions) in consumer materials.

MINI 4WD

Take one paragraph of a master class entry and say what each sentence does to the claim, including a sentence that only narrows it. If a header or a caption is there, say what that feature does in the piece. (Source: Mini Manners)

RI.8.6 CA

Grade 8

STANDARD

Determine an author's point of view or purpose in a text and analyze how the author acknowledges and responds to conflicting evidence or viewpoints. 51 English Language Arts 6-12 |

MINI 4WD

State the master class purpose in leaving slot-car track power out. Then show how the entry answers the opposing view that Mini 4WD and slot cars are the same kind of race. (Source: Mini Manners)

RL.8.10 CA

Grade 8

STANDARD

By the end of the year, read and comprehend literature, including stories, dramas, and poems, at the high end of grades 6-8 text complexity band independently and proficiently. 48 English Language Arts 6-12 |

MINI 4WD

Read, on your own, one Ad Finem part page and one master class entry that tells its rule as a scene. Retell both at the level of the pages, not as a sketch. (Source: Ad Finem Liminis, Mini Manners)

RL.8.4 CA

Grade 8

STANDARD

See grade 8 Language standards 4-6 for additional expectations.

MINI 4WD

Do the grade 8 language work on the brake page: the tone of "break" beside "brake," and the way that pair points at another sense of stopping. (Source: Ad Finem Liminis)

RL.8.6 CA

Grade 8

STANDARD

Analyze how differences in the points of view of the characters and the audience or reader (e.g., created through the use of dramatic irony) create such effects as suspense or humor. 47 English Language Arts 6-12 |

MINI 4WD

The builder at the table knows the pinion count. The reader of the story does not, until the inspection line. Use that gap the way dramatic irony works, and say whether it makes the scene tense or funny. (Source: Mini Manners)

SL.8.3 CA

Grade 8

STANDARD

Delineate a speaker's argument and specific claims, evaluating the soundness of the reasoning and relevance and sufficiency of the evidence and identifying when irrelevant evidence is introduced. 66 English Language Arts 6-12 |

MINI 4WD

Lay out a speaker's claim that any pinion is legal. Test the reasoning against the 8-tooth sentence, and name any detail, such as the body latch, that does not count as evidence. (Source: Mini Manners)

SL.8.4 CA

Grade 8

STANDARD

Present claims and findings (e.g., argument, narrative, response to literature presentations), emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. a. Plan and present a narrative that: establishes a context and point of view, presents a logical sequence, uses narrative techniques (e.g., dialogue, pacing, description, sensory language), uses a variety of transitions, and provides a conclusion that reflects the experience.

MINI 4WD

Tell a narrative of one build: a point of view, Step 4 then Step 10 then Step 16, one line of talk, and an ending that looks back at the snap. Speak so the part names are clear. (Source: Ad Finem Liminis)

SL.8.6 CA

Grade 8

STANDARD

Adapt speech to a variety of contexts and tasks, demonstrating command of formal English when indicated or appropriate. 67 English Language Arts 6-12 |

MINI 4WD

Give the inspection facts in formal speech to an official, and the same facts in ordinary speech to a new builder. Change the speech to the task. Do not change the tooth count you counted. (Source: Mini Manners)

SL.8.6 CA

Grade 8

STANDARD

See grade 8 Language standards 1 and 3 for specific expectations.

MINI 4WD

In either of those talks, keep verb voice and mood steady unless you shift them for a reason you can name. That is the grade 8 language work on the speech. (Source: Mini Manners)

W.8.1 CA

Grade 8

STANDARD

Write arguments to support claims with clear reasons and relevant evidence. a. Introduce claim(s), acknowledge and distinguish the claim(s) from alternate or opposing claims, and organize the reasons and evidence logically. b. Support claim(s) with logical reasoning and relevant evidence, using accurate, credible sources and demonstrating an understanding of the topic or text. c. Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), counterclaims, reasons, and evidence. d. Establish and maintain a formal style. e. Provide a concluding statement or section that follows from and supports the argument presented. 56 English Language Arts 6-12 |

MINI 4WD

Argue that the car at the line must be the car that was marked at inspection. Distinguish that claim from the opposing claim that a look-alike car is close enough, and close on the evidence. (Source: Mini Manners)

W.8.10 CA

Grade 8

STANDARD

Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences. 60 English Language Arts 6-12 |

MINI 4WD

Keep the practice going: a short note the day you fit the counter gear, and a longer revised note after you have run the car and reread the step. (Source: Ad Finem Liminis)

W.8.2 CA

Grade 8

STANDARD

Write informative/explanatory texts, including career development documents (e.g., simple business letters and job applications), to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. a. Introduce a topic or thesis statement clearly, previewing what is to follow; organize ideas, concepts, and information into broader categories; include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension. b. Develop the topic with relevant, well-chosen facts, definitions, concrete details, quotations, or other information and examples. c. Use appropriate and varied transitions to create cohesion and clarify the relationships among ideas and concepts. d. Use precise language and domain-specific vocabulary to inform about or explain the topic. e. Establish and maintain a formal style. f. Provide a concluding statement or section that follows from and supports the information or explanation presented. 57 English Language Arts 6-12 |

MINI 4WD

Explain the brake for a reader who may build the car. Include a heading, the 2×5 mm measure, the words "Turn chassis over," and a closing line that follows from the friction sentence. A simple letter to the next builder can carry the same explanation. (Source: Ad Finem Liminis)

W.8.3 CA

Grade 8

STANDARD

Write narratives to develop real or imagined experiences or events using effective technique, relevant descriptive details, and well-structured event sequences. a. Engage and orient the reader by establishing a context and point of view and introducing a narrator and/or characters; organize an event sequence that unfolds naturally and logically. b. Use narrative techniques, such as dialogue, pacing, description, and reflection, to develop experiences, events, and/or characters. c. Use a variety of transition words, phrases, and clauses to convey sequence, signal shifts from one time frame or setting to another, and show the relationships among experiences and events. d. Use precise words and phrases, relevant descriptive details, and sensory language to capture the action and convey experiences and events. e. Provide a conclusion that follows from and reflects on the narrated experiences or events. 58 English Language Arts 6-12 |

MINI 4WD

Write a narrative of a heat with a point of view, a sequence through the cross-over, talk or a pause, and an ending that reflects on the lane. The car has no driver at a controller while it runs. (Source: Mini Manners)

W.8.5 CA, OH

Grade 8

STANDARD

With some guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on how well purpose and audience have been addressed. (Editing for conventions should demonstrate command of Language standards 1-3 up to and including grade 8.)

MINI 4WD

Revise that narrative for a reader who was not there. Check purpose, order, and whether "SNAP!" and the brake are precise enough that the reader can see them. (Source: Ad Finem Liminis, Mini Manners)

W.8.8 CA

Grade 8

STANDARD

Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. 59 English Language Arts 6-12 |

MINI 4WD

Gather a quotation from Ad Finem and one from the master class. Judge each source, paraphrase one finding, and cite both in a format you can repeat. Do not present a letter reading as if it were a measured time. (Source: Ad Finem Liminis, Mini Manners)

Mathematics

81 standards

Mathematics · Grade 6

29 standards

6.RP.1 CC, CA, MI, NJ, OH

Grade 6

STANDARD

Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. For example, "The ratio of wings to beaks in the bird house at the zoo was 2:1, because for every 2 wings there was 1 beak." "For every vote candidate A received, candidate C received nearly three votes."

MINI 4WD

Count the teeth on the crown gear and on the pinion. Say the ratio in words: for every tooth on the pinion, how many teeth on the crown. The master class legal pinion is the 8-tooth, so count that one if it is the pinion on the car. (Source: Ad Finem Liminis, Mini Manners)

6.RP.2 CC, CA, MI

Grade 6

STANDARD

Understand the concept of a unit rate a/b associated with a ratio a:b with b ≠ 0, and use rate language in the context of a ratio relationship. For example, "This recipe has a ratio of 3 cups of flour to 4 cups of sugar, so there is 3/4 cup of flour for each cup of sugar." "We paid $75 for 15 hamburgers, which is a rate of $5 per hamburger." Expectations for unit rates in this grade are limited to non-complex fractions.

MINI 4WD

Time the car along a straight you have measured. State the unit rate as a length for one second. If you use the 8-tooth pinion and a crown you have counted, you may also state teeth on the crown for one tooth on the pinion. (Source: Ad Finem Liminis, Mini Manners)

6.RP.3 CC, CA, MI, NJ, OH

Grade 6

STANDARD

Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations. a. Make tables of equivalent ratios relating quantities with whole-number measurements, find missing values in the tables, and plot the pairs of values on the coordinate plane. Use tables to compare ratios. b. Solve unit rate problems including those involving unit pricing and constant speed. For example, if it took 7 hours to mow 4 lawns, then at that rate, how many lawns could be mowed in 35 hours? At what rate were lawns being mowed? c. Find a percent of a quantity as a rate per 100 (e.g., 30% of a quantity means 30/100 times the quantity); solve problems involving finding the whole, given a part and the percent. d. Use ratio reasoning to convert measurement units; manipulate and transform units appropriately when multiplying or dividing quantities.

MINI 4WD

Make a table of crown-gear teeth against pinion teeth for the 8-tooth and for one other count you only write down, not one you fit. Find a percent of heats the car finishes, out of 100. Convert the 2×5 mm screw into centimeters. (Source: Ad Finem Liminis, Mini Manners)

6.NS.1 CC, CA, MI

Grade 6

STANDARD

Interpret and compute quotients of fractions, and solve word problems involving division of fractions by fractions, e.g., by using visual fraction models and equations to represent the problem. For example, create a story context for (2/3) ÷ (3/4) and use a visual fraction model to show the quotient; use the relationship between multiplication and division to explain that (2/3) ÷ (3/4) = 8/9 because 3/4 of 8/9 is 2/3. (In general, (a/b) ÷ (c/d) = ad/bc.) How much chocolate will each person get if 3 people share 1/2 lb of chocolate equally? How many 3/4-cup servings are in 2/3 of a cup of yogurt? How wide is a rectangular strip of land with length 3/4 mi and area 1/2 square mi?

MINI 4WD

Mark a straight on the lane as a fraction of a meter, and cut that length into equal shorter pieces. Write the division of fractions that matches the cut, and tell the story of the tape in words. (Source: Cursor)

6.NS.2 CC, CA, MI

Grade 6

STANDARD

Fluently divide multi-digit numbers using the standard algorithm.

MINI 4WD

Time a heat in milliseconds and divide by the number of laps you counted. Use the ordinary division algorithm, and keep the unit in the answer. (Source: Cursor)

6.NS.3 CC, CA, MI

Grade 6

STANDARD

Fluently add, subtract, multiply, and divide multi-digit decimals using the standard algorithm for each operation.

MINI 4WD

Record two lap times in seconds, to the hundredth. Add them, then subtract the shorter from the longer, using the decimal algorithm. (Source: Cursor)

6.NS.4 CC, CA, MI, NJ, OH

Grade 6

STANDARD

Find the greatest common factor of two whole numbers less than or equal to 100 and the least common multiple of two whole numbers less than or equal to 12. Use the distributive property to express a sum of two whole numbers 1-100 with a common factor as a multiple of a sum of two whole numbers with no common factor. For example, express 36 + 8 as 4 (9 + 2).

MINI 4WD

Count two tooth numbers, each 100 or under, and find their greatest common factor. For a 3-lane track and a lap count of 4, find the least common multiple, which is a number of laps at which every lane has had the same count of starts if you rotate evenly. (Source: Mini Manners)

6.NS.5 CC, CA, MI, NJ, OH

Grade 6

STANDARD

Understand that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below zero, elevation above/below sea level, credits/debits, positive/negative electric charge); use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation.

MINI 4WD

Call the start line 0. A car past the line, along the lane, is a positive distance. A car still behind the line is a negative distance. Say what 0 means: the car is on the start line. (Source: Cursor)

6.NS.6 CC, CA, MI, NJ, OH

Grade 6

STANDARD

Understand a rational number as a point on the number line. Extend number line diagrams and coordinate axes familiar from previous grades to represent points on the line and in the plane with negative number coordinates. a. Recognize opposite signs of numbers as indicating locations on opposite sides of 0 on the number line; recognize that the opposite of the opposite of a number is the number itself, e.g., -(-3) = 3, and that 0 is its own opposite. b. Understand signs of numbers in ordered pairs as indicating locations in quadrants of the coordinate plane; recognize that when two ordered pairs differ only by signs, the locations of the points are related by reflections across one or both axes. c. Find and position integers and other rational numbers on a horizontal or vertical number line diagram; find and position pairs of integers and other rational numbers on a coordinate plane.

MINI 4WD

Lay the lane as a number line with 0 at the start, and mark a positive and a negative position. On a sketch, put the motor mount at the origin and plot one axle point in a quadrant given by the signs of its coordinates. (Source: Ad Finem Liminis)

6.NS.7 CC, CA, MI, NJ, OH

Grade 6

STANDARD

Understand ordering and absolute value of rational numbers. a. Interpret statements of inequality as statements about the relative position of two numbers on a number line diagram. For example, interpret -3 > -7 as a statement that -3 is located to the right of -7 on a number line oriented from left to right. b. Write, interpret, and explain statements of order for rational numbers in real-world contexts. For example, write -3 °C > -7 °C to express the fact that -3 °C is warmer than -7 °C. c. Understand the absolute value of a rational number as its distance from 0 on the number line; interpret absolute value as magnitude for a positive or negative quantity in a real-world situation. For example, for an account balance of -30 dollars, write |-30| = 30 to describe the size of the debt in dollars. d. Distinguish comparisons of absolute value from statements about order. For example, recognize that an account balance less than -30 dollars represents a debt greater than 30 dollars.

MINI 4WD

A car 0.2 s ahead of a target and a car 0.5 s behind it are not ordered by how "big" the miss feels. Order the signed times, then take absolute values and say that the absolute value is the size of the miss, not the side of the target. (Source: Cursor)

6.NS.8 CC, CA, MI, NJ, OH

Grade 6

STANDARD

Solve real-world and mathematical problems by graphing points in all four quadrants of the coordinate plane. Include use of coordinates and absolute value to find distances between points with the same first coordinate or the same second coordinate.

MINI 4WD

On a diagram with the origin at the motor mount, plot two points that share an x-coordinate or a y-coordinate, such as two places along one axle. Use absolute value to find the distance between them. (Source: Ad Finem Liminis)

6.EE.1 CC, CA, MI, NJ, OH

Grade 6

STANDARD

Write and evaluate numerical expressions involving whole-number exponents.

MINI 4WD

The screw is marked 2×5 mm, which means 2 millimeters by 5 millimeters, not 2 to the fifth power. Write 2 separately, evaluate it, and keep that power away from the screw's mark. (Source: Ad Finem Liminis)

6.EE.2 CC, CA, MI, NJ

Grade 6

STANDARD

Write, read, and evaluate expressions in which letters stand for numbers. a. Write expressions that record operations with numbers and with letters standing for numbers. For example, express the calculation "Subtract y from 5" as 5 - y. b. Identify parts of an expression using mathematical terms (sum, term, product, factor, quotient, coefficient); view one or more parts of an expression as a single entity. For example, describe the expression 2 (8 + 7) as a product of two factors; view (8 + 7) as both a single entity and a sum of two terms. c. Evaluate expressions at specific values of their variables. Include expressions that arise from formulas used in real-world problems. Perform arithmetic operations, including those involving whole-number exponents, in the conventional order when there are no parentheses to specify a particular order (Order of Operations). For example, use the formulas $V = s^3$ and $A = 6\ s^2$ to find the volume and surface area of a cube with sides of length $s = 1/2$.

MINI 4WD

Let t be the number of teeth you count on the crown gear. Write t/8 for the ratio of those teeth to an 8-tooth pinion. Name t/8 as a quotient, and evaluate it once you have counted t. (Source: Ad Finem Liminis, Mini Manners)

6.EE.3 CC, CA, MI, NJ, OH

Grade 6

STANDARD

Apply the properties of operations to generate equivalent expressions. For example, apply the distributive property to the expression 3 (2 + x) to produce the equivalent expression 6 + 3x; apply the distributive property to the expression 24x + 18y to produce the equivalent expression 6 (4x + 3y); apply properties of operations to y + y + y to produce the equivalent expression 3y.

MINI 4WD

Three 8-tooth pinions have 8+8+8 teeth. Write that sum as 3×8, and write 2(8+t) in the distributed form 16+2t, where t is a crown-gear count. (Source: Ad Finem Liminis, Mini Manners)

6.EE.4 CC, CA, MI, NJ, OH

Grade 6

STANDARD

Identify when two expressions are equivalent (i.e., when the two expressions name the same number regardless of which value is substituted into them). For example, the expressions y + y + y and 3y are equivalent because they name the same number regardless of which number y stands for.

MINI 4WD

For any crown-gear tooth count t, t/8 and 2t/16 name the same ratio to an 8-tooth pinion. Substitute two different counts and show that both expressions give the same number. (Source: Ad Finem Liminis, Mini Manners)

6.EE.5 CC, CA, MI, NJ, OH

Grade 6

STANDARD

Understand solving an equation or inequality as a process of answering a question: which values from a specified set, if any, make the equation or inequality true? Use substitution to determine whether a given number in a specified set makes an equation or inequality true.

MINI 4WD

The master class equation for the legal pinion is teeth = 8. Test 8, 9, and 10 by substitution, and say which values make the equation true. (Source: Mini Manners)

6.EE.6 CC, CA, MI, NJ, OH

Grade 6

STANDARD

Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set.

MINI 4WD

Let m be the mass of the car in grams, a number you do not know until you weigh it. Write m + s for the mass after a screw of mass s is added. The letter stands for a number, not for the part's name. (Source: Ad Finem Liminis)

6.EE.7 CC, CA, MI, NJ, OH

Grade 6

STANDARD

Solve real-world and mathematical problems by writing and solving equations of the form x + p = q and px = q for cases in which p, q and x are all nonnegative rational numbers.

MINI 4WD

Measure a chassis length q in millimeters, of which p millimeters are already marked. Solve x + p = q for the unmarked part. Keep the numbers nonnegative, as lengths are. (Source: Ad Finem Liminis)

6.EE.8 CC, CA, MI, NJ, OH

Grade 6

STANDARD

Write an inequality of the form x > c or x < c to represent a constraint or condition in a real-world or mathematical problem. Recognize that inequalities of the form x > c or x < c have infinitely many solutions; represent solutions of such inequalities on number line diagrams.

MINI 4WD

Measure the lane width. Write w < that width for a car that must sit inside the lane. Show on a number line that many widths satisfy it, not one. (Source: Cursor)

6.EE.9 CC, CA, MI, NJ, OH

Grade 6

STANDARD

Use variables to represent two quantities in a real-world problem that change in relationship to one another; write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation. For example, in a problem involving motion at constant speed, list and graph ordered pairs of distances and times, and write the equation d = 65t to represent the relationship between distance and time.

MINI 4WD

Time one steady push along a measured straight. Let t be the seconds and d the millimeters. Write d in terms of t with the speed you measured, and make a table of a few times and distances. (Source: Cursor)

6.G.1 CC, CA, MI, NJ

Grade 6

STANDARD

Find the area of right triangles, other triangles, special quadrilaterals, and polygons by composing into rectangles or decomposing into triangles and other shapes; apply these techniques in the context of solving real-world and mathematical problems.

MINI 4WD

Trace the brake from the Ad Finem drawing. Split the tracing into rectangles and triangles, find those areas, and add them. (Source: Ad Finem Liminis)

6.G.2 CC, CA, MI, NJ

Grade 6

STANDARD

Find the volume of a right rectangular prism with fractional edge lengths by packing it with unit cubes of the appropriate unit fraction edge lengths, and show that the volume is the same as would be found by multiplying the edge lengths of the prism. Apply the formulas V = l w h and V = b h to find volumes of right rectangular prisms with fractional edge lengths in the context of solving real-world and mathematical problems.

MINI 4WD

Measure a small rectangular box that can hold the two cells shown on the battery page. Find its volume by packing unit cubes or by V = lwh, and keep the unit in the answer. (Source: Ad Finem Liminis)

6.G.3 CC, CA, MI, NJ, OH

Grade 6

STANDARD

Draw polygons in the coordinate plane given coordinates for the vertices; use coordinates to find the length of a side joining points with the same first coordinate or the same second coordinate. Apply these techniques in the context of solving real-world and mathematical problems.

MINI 4WD

Assign coordinates to the corners of a chassis rectangle you measured. Draw it on the plane, and find the length of a side whose ends share an x-coordinate or a y-coordinate. (Source: Ad Finem Liminis)

6.G.4 CC, CA, MI, OH

Grade 6

STANDARD

Represent three-dimensional figures using nets made up of rectangles and triangles, and use the nets to find the surface area of these figures. Apply these techniques in the context of solving real-world and mathematical problems.

MINI 4WD

Make a net of rectangles for a box around the two cells. Find the surface area from the net, and say which face is the one the switch terminals face. (Source: Ad Finem Liminis)

6.SP.1 CC, CA, MI, NJ

Grade 6

STANDARD

Recognize a statistical question as one that anticipates variability in the data related to the question and accounts for it in the answers. For example, "How old am I?" is not a statistical question, but "How old are the students in my school?" is a statistical question because one anticipates variability in students' ages.

MINI 4WD

"How long was this one heat?" does not anticipate a spread of answers. "How long are the heats in this round?" does, because the times vary. Use the second as the statistical question. (Source: Cursor)

6.SP.2 CC, CA, MI, NJ, OH

Grade 6

STANDARD

Understand that a set of data collected to answer a statistical question has a distribution which can be described by its center, spread, and overall shape.

MINI 4WD

Collect the heat times for that question. Describe the pile by its center, how spread out it is, and the shape you see. (Source: Cursor)

6.SP.3 CC, CA, MI, NJ, OH

Grade 6

STANDARD

Recognize that a measure of center for a numerical data set summarizes all of its values with a single number, while a measure of variation describes how its values vary with a single number.

MINI 4WD

The mean heat time is one number for the whole set. A measure of variation is a different number, for how far the times sit from one another. Report both, and do not use one in place of the other. (Source: Cursor)

6.SP.4 CC, CA, MI, NJ

Grade 6

STANDARD

Display numerical data in plots on a number line, including dot plots, histograms, and box plots.

MINI 4WD

Put the heat times on a dot plot, a histogram, or a box plot along a number line in seconds. (Source: Cursor)

6.SP.5 CC, CA, MI, NJ

Grade 6

STANDARD

Summarize numerical data sets in relation to their context, such as by: a. Reporting the number of observations. b. Describing the nature of the attribute under investigation, including how it was measured and its units of measurement. c. Giving quantitative measures of center (median and/or mean) and variability (interquartile range and/or mean absolute deviation), as well as describing any overall pattern and any striking deviations from the overall pattern with reference to the context in which the data were gathered. d. Relating the choice of measures of center and variability to the shape of the data distribution and the context in which the data were gathered.

MINI 4WD

Say how many heats you timed, that the unit is seconds, and the mean or median and a measure of spread. Point to any heat that left the lane as a departure from the pattern. (Source: Cursor)

Mathematics · Grade 7

24 standards

7.RP.1 CC, CA, MI, NJ, OH

Grade 7

STANDARD

Compute unit rates associated with ratios of fractions, including ratios of lengths, areas and other quantities measured in like or different units. For example, if a person walks 1/2 mile in each 1/4 hour, compute the unit rate as the complex fraction (1/2)/(1/4) miles per hour, equivalently 2 miles per hour.

MINI 4WD

If the car covers 1/2 meter in 1/4 second along a straight you marked, compute the unit rate as (1/2)/(1/4) meters per second. You may instead use two lengths you actually measured, including a fraction. (Source: Cursor)

7.RP.2 CC, CA, MI, NJ, OH

Grade 7

STANDARD

Recognize and represent proportional relationships between quantities. a. Decide whether two quantities are in a proportional relationship, e.g., by testing for equivalent ratios in a table or graphing on a coordinate plane and observing whether the graph is a straight line through the origin. b. Identify the constant of proportionality (unit rate) in tables, graphs, equations, diagrams, and verbal descriptions of proportional relationships. c. Represent proportional relationships by equations. For example, if total cost t is proportional to the number n of items purchased at a constant price p, the relationship between the total cost and the number of items can be expressed as t = pn. d. Explain what a point (x, y) on the graph of a proportional relationship means in terms of the situation, with special attention to the points (0, 0) and (1, r) where r is the unit rate.

MINI 4WD

Make a table of pinion turns against crown-gear turns. Decide whether the pairs stay proportional. If they do, name the constant, write the equation, and say what the point (1, r) means for one pinion turn. (Source: Ad Finem Liminis)

7.RP.3 CC, CA, MI, NJ, OH

Grade 7

STANDARD

Use proportional relationships to solve multistep ratio and percent problems. Examples: simple interest, tax, markups and markdowns, gratuities and commissions, fees, percent increase and decrease, percent error.

MINI 4WD

Predict a heat time, run the heat, and find the percent error. Separately, find the percent of heats, out of the heats you ran, in which the car stayed in the lane. (Source: Cursor)

7.NS.1 CC, CA, MI, OH

Grade 7

STANDARD

Apply and extend previous understandings of addition and subtraction to add and subtract rational numbers; represent addition and subtraction on a horizontal or vertical number line diagram. a. Describe situations in which opposite quantities combine to make 0. For example, a hydrogen atom has 0 charge because its two constituents are oppositely charged. b. Understand p + q as the number located a distance |q| from p, in the positive or negative direction depending on whether q is positive or negative. Show that a number and its opposite have a sum of 0 (are additive inverses). Interpret sums of rational numbers by describing real-world contexts. c. Understand subtraction of rational numbers as adding the additive inverse, p - q = p + (-q). Show that the distance between two rational numbers on the number line is the absolute value of their difference, and apply this principle in real-world contexts. d. Apply properties of operations as strategies to add and subtract rational numbers.

MINI 4WD

A gain of 0.2 s on a target and a loss of 0.2 s land on opposite sides of the target and combine to 0. Show that on a number line, and write the loss as adding the opposite. (Source: Cursor)

7.NS.2 CC, CA, MI, NJ, OH

Grade 7

STANDARD

Apply and extend previous understandings of multiplication and division and of fractions to multiply and divide rational numbers. a. Understand that multiplication is extended from fractions to rational numbers by requiring that operations continue to satisfy the properties of operations, particularly the distributive property, leading to products such as (-1)(-1) = 1 and the rules for multiplying signed numbers. Interpret products of rational numbers by describing real-world contexts. b. Understand that integers can be divided, provided that the divisor is not zero, and every quotient of integers (with non-zero divisor) is a rational number. If p and q are integers, then -(p/q) = (-p)/q = p/(-q). Interpret quotients of rational numbers by describing real-world contexts. c. Apply properties of operations as strategies to multiply and divide rational numbers. d. Convert a rational number to a decimal using long division; know that the decimal form of a rational number terminates in 0s or eventually repeats.

MINI 4WD

The crown gear reverses the sense of the turn relative to the pinion. Call one direction positive and the other negative, multiply the signed turns, and convert one rational tooth ratio to a decimal by division. (Source: Ad Finem Liminis)

7.NS.3 CC, CA, MI, OH

Grade 7

STANDARD

Solve real-world and mathematical problems involving the four operations with rational numbers. Computations with rational numbers extend the rules for manipulating fractions to complex fractions.

MINI 4WD

Using the signed times and the tooth ratio from the last two cards, compute one heat result that needs more than one operation. Estimate first, then compute, and say whether the answer is a sensible time or a ratio. (Source: Cursor, Ad Finem Liminis)

7.EE.1 CC, CA, MI, NJ, OH

Grade 7

STANDARD

Apply properties of operations as strategies to add, subtract, factor, and expand linear expressions with rational coefficients.

MINI 4WD

Let t be the crown-gear tooth count. Add 8t + 8t, then factor, and expand 2(8 + t). The 8 is the legal pinion's tooth count in the master class account. (Source: Ad Finem Liminis, Mini Manners)

7.EE.2 CC, CA, MI, NJ

Grade 7

STANDARD

Understand that rewriting an expression in different forms in a problem context can shed light on the problem and how the quantities in it are related. For example, a + 0.05a = 1.05a means that "increase by 5%" is the same as "multiply by 1.05."

MINI 4WD

A car of mass m, plus another twentieth of that mass in screws, is m + 0.05m. Rewrite it as 1.05m, and say what the new form makes visible about the mass. (Source: Ad Finem Liminis)

7.EE.3 CC, CA, MI, NJ, OH

Grade 7

STANDARD

Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. For example: If a woman making $25 an hour gets a 10% raise, she will make an additional 1/10 of her salary an hour, or $2.50, for a new salary of $27.50. If you want to place a towel bar 9 3/4 inches long in the center of a door that is 27 1/2 inches wide, you will need to place the bar about 9 inches from each edge; this estimate can be used as a check on the exact computation.

MINI 4WD

Estimate whether three laps at about the lap time you measured will fit in a heat whose length you also measured. Then compute exactly, and use the estimate as the check. (Source: Cursor)

7.EE.4 CC, CA, MI, OH

Grade 7

STANDARD

Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. a. Solve word problems leading to equations of the form px + q = r and p(x + q) = r, where p, q, and r are specific rational numbers. Solve equations of these forms fluently. Compare an algebraic solution to an arithmetic solution, identifying the sequence of the operations used in each approach. For example, the perimeter of a rectangle is 54 cm. Its length is 6 cm. What is its width? b. Solve word problems leading to inequalities of the form px + q > r or px + q < r, where p, q, and r are specific rational numbers. Graph the solution set of the inequality and interpret it in the context of the problem. For example: As a salesperson, you are paid $50 per week plus $3 per sale. This week you want your pay to be at least $100. Write an inequality for the number of sales you need to make, and describe the solutions.

MINI 4WD

Measure the length and width of the chassis. If the perimeter is the number you measured, write an equation of the form 2(l + w) = p and solve for the unknown side. For a limit, write an inequality for a heat time that must stay under the time you were given, graph it, and say what the solutions mean on the lane. (Source: Cursor, Ad Finem Liminis)

7.G.1 CC, CA, MI, NJ

Grade 7

STANDARD

Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale.

MINI 4WD

The axle drawing is a scale picture. Measure the drawn axle and the axle on the car, find the scale, and compute one real length from the drawing. Reproduce the drawing at a second scale. (Source: Ad Finem Liminis)

7.G.2 CC, CA, MI

Grade 7

STANDARD

Draw (freehand, with ruler and protractor, and with technology) geometric shapes with given conditions. Focus on constructing triangles from three measures of angles or sides, noticing when the conditions determine a unique triangle, more than one triangle, or no triangle.

MINI 4WD

From the roller, the wall, and a chassis edge, take three lengths. Try to draw the triangle. Say whether those three measures give one triangle, more than one, or none. (Source: Ad Finem Liminis)

7.G.3 CC, CA, MI, NJ, OH

Grade 7

STANDARD

Describe the two-dimensional figures that result from slicing three-dimensional figures, as in plane sections of right rectangular prisms and right rectangular pyramids.

MINI 4WD

Take a rectangular box that holds the two cells. A plane cut parallel to a face gives a rectangle. A slanted cut can give a triangle. Name the figure you actually get from the cut you make. (Source: Ad Finem Liminis)

7.G.4 CC, CA, MI, NJ

Grade 7

STANDARD

Know the formulas for the area and circumference of a circle and use them to solve problems; give an informal derivation of the relationship between the circumference and area of a circle.

MINI 4WD

The wheel and the crown gear are circles. Measure a diameter, compute the circumference, and use that circumference as the rollout of one turn. Give a short reason that the circumference and the area are tied through the radius. (Source: Ad Finem Liminis)

7.G.5 CC, CA, MI, NJ, OH

Grade 7

STANDARD

Use facts about supplementary, complementary, vertical, and adjacent angles in a multi-step problem to write and solve simple equations for an unknown angle in a figure.

MINI 4WD

In Step 4 the axle and the motor shaft meet at a right angle. Write an equation for that angle and for the angle beside it along a straight edge. Solve for any angle the drawing leaves unknown. (Source: Ad Finem Liminis)

7.G.6 CC, CA, MI, NJ, OH

Grade 7

STANDARD

Solve real-world and mathematical problems involving area, volume and surface area of two-and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms.

MINI 4WD

Find the area of the traced brake and the volume of the cell box. If the chassis can be split into rectangular blocks, add those volumes. Keep each unit with its measure. (Source: Ad Finem Liminis)

7.SP.1 CC, CA, MI, NJ

Grade 7

STANDARD

Understand that statistics can be used to gain information about a population by examining a sample of the population; generalizations about a population from a sample are valid only if the sample is representative of that population. Understand that random sampling tends to produce representative samples and support valid inferences.

MINI 4WD

Three cars on one lane are not automatically a fair sample of every car that might enter. Say when a sample of heat times would support a claim about the whole round, and when it would not. (Source: Cursor)

7.SP.2 CC, CA, MI, NJ

Grade 7

STANDARD

Use data from a random sample to draw inferences about a population with an unknown characteristic of interest. Generate multiple samples (or simulated samples) of the same size to gauge the variation in estimates or predictions. For example, estimate the mean word length in a book by randomly sampling words from the book; predict the winner of a school election based on randomly sampled survey data. Gauge how far off the estimate or prediction might be.

MINI 4WD

Draw a random sample of the heat times, estimate the mean, and draw another sample of the same size. Use the two estimates to say how far off a single sample might be. (Source: Cursor)

7.SP.3 CC, CA, MI, NJ

Grade 7

STANDARD

Informally assess the degree of visual overlap of two numerical data distributions with similar variabilities, measuring the difference between the centers by expressing it as a multiple of a measure of variability. For example, the mean height of players on the basketball team is 10 cm greater than the mean height of players on the soccer team, about twice the variability (mean absolute deviation) on either team; on a dot plot, the separation between the two distributions of heights is noticeable.

MINI 4WD

Compare times from a 3-lane track with times from a 5-lane track. Express the difference of the centers as a multiple of a measure of spread, and say whether the two piles separate on a plot. (Source: Mini Manners)

7.SP.4 CC, CA, MI, NJ

Grade 7

STANDARD

Use measures of center and measures of variability for numerical data from random samples to draw informal comparative inferences about two populations. For example, decide whether the words in a chapter of a seventh-grade science book are generally longer than the words in a chapter of a fourth-grade science book.

MINI 4WD

Using the centers and the spreads of those two groups, make an informal call about whether one track's heats run longer. Say that the call is about the groups you sampled. (Source: Mini Manners)

7.SP.5 CC, CA, MI, NJ, OH

Grade 7

STANDARD

Understand that the probability of a chance event is a number between 0 and 1 that expresses the likelihood of the event occurring. Larger numbers indicate greater likelihood. A probability near 0 indicates an unlikely event, a probability around 1/2 indicates an event that is neither unlikely nor likely, and a probability near 1 indicates a likely event.

MINI 4WD

If a lane is assigned at random on a 3-lane track, the probability of one named lane is 1/3. A sixth lane, on a track that has five, has probability 0. Say what a probability near 1/2 would mean for a fair two-way call at inspection. (Source: Mini Manners)

7.SP.6 CC, CA, MI, NJ, OH

Grade 7

STANDARD

Approximate the probability of a chance event by collecting data on the chance process that produces it and observing its long-run relative frequency, and predict the approximate relative frequency given the probability. For example, when rolling a number cube 600 times, predict that a 3 or 6 would be rolled roughly 200 times, but probably not exactly 200 times.

MINI 4WD

Assign lanes at random over many heats and record the share that land on one lane. Compare that long-run share with 1/3, and predict the share before you run the next set. (Source: Mini Manners)

7.SP.7 CC, CA, MI, NJ, OH

Grade 7

STANDARD

Develop a probability model and use it to find probabilities of events. Compare probabilities from a model to observed frequencies; if the agreement is not good, explain possible sources of the discrepancy. a. Develop a uniform probability model by assigning equal probability to all outcomes, and use the model to determine probabilities of events. For example, if a student is selected at random from a class, find the probability that Jane will be selected and the probability that a girl will be selected. b. Develop a probability model (which may not be uniform) by observing frequencies in data generated from a chance process. For example, find the approximate probability that a spinning penny will land heads up or that a tossed paper cup will land open-end down. Do the outcomes for the spinning penny appear to be equally likely based on the observed frequencies?

MINI 4WD

A fair model gives each of three lanes probability 1/3. If the master class case of first-come lane choice produces different frequencies, say that the model and the record disagree, and that the assignment was the source. (Source: Mini Manners)

7.SP.8 CC, CA, MI, NJ

Grade 7

STANDARD

Find probabilities of compound events using organized lists, tables, tree diagrams, and simulation. a. Understand that, just as with simple events, the probability of a compound event is the fraction of outcomes in the sample space for which the compound event occurs. b. Represent sample spaces for compound events using methods such as organized lists, tables and tree diagrams. For an event described in everyday language (e.g., "rolling double sixes"), identify the outcomes in the sample space which compose the event. c. Design and use a simulation to generate frequencies for compound events. For example, use random digits as a simulation tool to approximate the answer to the question: If 40% of donors have type A blood, what is the probability that it will take at least 4 donors to find one with type A blood?

MINI 4WD

List the outcomes for lane 1, 2, or 3 together with stayed-in or left-the-lane. Make a tree or a table. The compound event "lane 2 and stayed in" is the share of that list for which both happen. A short simulation with random digits can approximate it. (Source: Mini Manners)

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8.NS.1 CC, CA, MI, NJ

Grade 8

STANDARD

Know that numbers that are not rational are called irrational. Understand informally that every number has a decimal expansion; for rational numbers show that the decimal expansion repeats eventually, and convert a decimal expansion which repeats eventually into a rational number.

MINI 4WD

The ratio of two tooth counts is rational, and its decimal repeats or ends. The number π in the wheel's circumference does not. Show a repeating decimal from a tooth ratio, and turn it back into a fraction. (Source: Ad Finem Liminis)

8.NS.2 CC, CA, MI, OH

Grade 8

STANDARD

Use rational approximations of irrational numbers to compare the size of irrational numbers, locate them approximately on a number line diagram, and estimate the value of expressions (e.g., π^2). For example, by truncating the decimal expansion of $\sqrt{2}$, show that $\sqrt{2}$ is between 1 and 2, then between 1.4 and 1.5, and explain how to continue on to get better approximations.

MINI 4WD

A 1 by 1 square on the chassis grid has diagonal $\sqrt{2}$, which is irrational. Place $\sqrt{2}$ between two successive tenths by truncating its decimal, and do the same for a closer pair. (Source: Ad Finem Liminis)

8.EE.1 CC, CA, MI, NJ

Grade 8

STANDARD

Know and apply the properties of integer exponents to generate equivalent numerical expressions. For example, $3^2 \times 3^{-5} = 3^{-3} = 1/3^3 = 1/27$.

MINI 4WD

Write the screw's 2×5 mm mark as a product of lengths, not as a power. Separately, simplify a true power you need, such as 10^2 millimeters in a centimeter conversion, and show the exponent rule you used. (Source: Ad Finem Liminis)

8.EE.2 CC, CA, MI, OH

Grade 8

STANDARD

Use square root and cube root symbols to represent solutions to equations of the form $x^2 = p$ and $x^3 = p$, where p is a positive rational number. Evaluate square roots of small perfect squares and cube roots of small perfect cubes. Know that $\sqrt{2}$ is irrational.

MINI 4WD

If a square region on the chassis has area 49 square millimeters, the side is $\sqrt{49}$. Evaluate that root. Know that $\sqrt{2}$, the diagonal factor of a 1 by 1 square, is not a rational number. (Source: Ad Finem Liminis)

8.EE.3 CC, CA, MI, NJ, OH

Grade 8

STANDARD

Use numbers expressed in the form of a single digit times an integer power of 10 to estimate very large or very small quantities, and to express how many times as much one is than the other. For example, estimate the population of the United States as 3×10 and the population of the world as 7×10, and determine that the world population is more than 20 times larger.

MINI 4WD

Write a very small gap, in millimeters, as a single digit times a power of 10. Compare it with a larger gap you measured, and say how many times as large the larger gap is. (Source: Cursor)

8.EE.4 CC, CA, MI, NJ

Grade 8

STANDARD

Perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. Use scientific notation and choose units of appropriate size for measurements of very large or very small quantities (e.g., use millimeters per year for seafloor spreading). Interpret scientific notation that has been generated by technology.

MINI 4WD

Write 2 mm as 2×10^{-3} meters, and compute with that form when you add a length that you still have in millimeters. Choose millimeters or meters so the screw and the lane are not left in a clumsy size. (Source: Ad Finem Liminis)

8.EE.5 CC, CA, MI, NJ, OH

Grade 8

STANDARD

Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways. For example, compare a distance-time graph to a distance-time equation to determine which of two moving objects has greater speed.

MINI 4WD

Graph distance against time for one push along a straight. Read the slope as the speed. Compare that graph with a second car's distance-time equation, and say which car is faster. (Source: Cursor)

8.EE.6 CC, CA, MI, NJ, OH

Grade 8

STANDARD

Use similar triangles to explain why the slope m is the same between any two distinct points on a non-vertical line in the coordinate plane; derive the equation y = mx for a line through the origin and the equation y = mx + b for a line intercepting the vertical axis at b.

MINI 4WD

On that distance-time line, draw two slope triangles of different sizes. Use the similar triangles to explain why the slope is the same, and write the line as y = mx or y = mx + b if the car had a head start. (Source: Cursor)

8.EE.7 CC, CA, MI, NJ, OH

Grade 8

STANDARD

Solve linear equations in one variable. a. Give examples of linear equations in one variable with one solution, infinitely many solutions, or no solutions. Show which of these possibilities is the case by successively transforming the given equation into simpler forms, until an equivalent equation of the form x = a, a = a, or a = b results (where a and b are different numbers). b. Solve linear equations with rational number coefficients, including equations whose solutions require expanding expressions using the distributive property and collecting like terms.

MINI 4WD

Solve a linear equation for an unknown chassis length. Also show one equation about the pinion that has a single solution (teeth = 8), one that is true for every count because both sides match, and one that has no solution because it asks the same pinion to be 8 and 10. (Source: Ad Finem Liminis, Mini Manners)

8.EE.8 CA

Grade 8

STANDARD

Analyze and solve pairs of simultaneous linear equations. a. Understand that solutions to a system of two linear equations in two variables correspond to points of intersection of their graphs, because points of intersection satisfy both equations simultaneously. b. Solve systems of two linear equations in two variables algebraically, and estimate solutions by graphing the equations. Solve simple cases by inspection. For example, 3x + 2y = 5 and 3x + 2y = 6 have no solution because 3x + 2y cannot simultaneously be 5 and 6. c. Solve real-world and mathematical problems leading to to linear equations in two variables. For example, given coordinates for two pairs of points, determine whether the line through the first pair of points intersects the line through the second pair.

MINI 4WD

Write a distance equation for each of two cars, using speeds you measured, and give one car a head start. The solution is the time and place that satisfy both equations, the intersection of the two graphs. If the equations contradict, as when one rule sets a sum to 5 and another sets the same sum to 6, say that no point satisfies both. (Source: Cursor)

8.F.1 CC, CA, MI, OH

Grade 8

STANDARD

Understand that a function is a rule that assigns to each input exactly one output. The graph of a function is the set of ordered pairs consisting of an input and the corresponding output. Function notation is not required in Grade 8.

MINI 4WD

For one run, each time t has one distance along the lane. That pairing is a function. A single time with two distances for the same car would not be. You do not need function notation. (Source: Cursor)

8.F.2 CC, CA, MI, OH

Grade 8

STANDARD

Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a linear function represented by a table of values and a linear function represented by an algebraic expression, determine which function has the greater rate of change.

MINI 4WD

Put one car's distances in a table and the other's in an equation. Compare the rates of change, and say which car gains distance faster. (Source: Cursor)

8.F.3 CC, CA, MI, NJ, OH

Grade 8

STANDARD

Interpret the equation y = mx + b as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. For example, the function A = s^2 giving the area of a square as a function of its side length is not linear because its graph contains the points (1,1), (2,4) and (3,9), which are not on a straight line.

MINI 4WD

Distance against time at a steady speed is a line, y = mx + b. The area of the wheel is not linear in the diameter, because it follows a square of the radius. Check that a table of diameters and areas is not a straight line. (Source: Cursor, Ad Finem Liminis)

8.F.4 CC, CA, MI, NJ, OH

Grade 8

STANDARD

Construct a function to model a linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a relationship or from two (x, y) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values.

MINI 4WD

From a head start and a speed you measured, build the linear function for distance. Name the rate of change and the initial value, on the graph and in the situation. (Source: Cursor)

8.F.5 CC, CA, MI, NJ, OH

Grade 8

STANDARD

Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally.

MINI 4WD

The master class says the car gains speed each lap, and the brake page says the brake reduces momentum at the tire. Sketch speed against time for a heat: rising through the laps, with a dip at the brake. Say where the graph is increasing and where it turns. (Source: Ad Finem Liminis, Mini Manners)

8.G.1 CC, CA, MI

Grade 8

STANDARD

Verify experimentally the properties of rotations, reflections, and translations: a. Lines are taken to lines, and line segments to line segments of the same length. b. Angles are taken to angles of the same measure. c. Parallel lines are taken to parallel lines.

MINI 4WD

Step 16 says "Turn chassis over." Trace the brake, then turn or flip the tracing. Check that lines stay lines, lengths stay the same, and angles stay the same. (Source: Ad Finem Liminis)

8.G.2 CC, CA, MI, NJ

Grade 8

STANDARD

Understand that a two-dimensional figure is congruent to another if the second can be obtained from the first by a sequence of rotations, reflections, and translations; given two congruent figures, describe a sequence that exhibits the congruence between them.

MINI 4WD

The two 2×5 mm screws are the same shape. Describe a translation, rotation, or reflection that takes one screw's drawing onto the other. That sequence is the congruence. (Source: Ad Finem Liminis)

8.G.3 CC, CA, MI, NJ, OH

Grade 8

STANDARD

Describe the effect of dilations, translations, rotations, and reflections on two-dimensional figures using coordinates.

MINI 4WD

Put the axle on a coordinate grid and reflect it across the chassis centerline. Give the new coordinates, and say what the reflection did to the length. (Source: Ad Finem Liminis)

8.G.4 CC, CA, MI, NJ

Grade 8

STANDARD

Understand that a two-dimensional figure is similar to another if the second can be obtained from the first by a sequence of rotations, reflections, translations, and dilations; given two similar two-dimensional figures, describe a sequence that exhibits the similarity between them.

MINI 4WD

The axle drawing and the axle on the car are the same shape at different sizes. Describe the dilation, and any turn or flip, that takes the drawing onto the car's axle. (Source: Ad Finem Liminis)

8.G.5 CC, CA, MI, NJ, OH

Grade 8

STANDARD

Use informal arguments to establish facts about the angle sum and exterior angle of triangles, about the angles created when parallel lines are cut by a transversal, and the angle-angle criterion for similarity of triangles. For example, arrange three copies of the same triangle so that the sum of the three angles appears to form a line, and give an argument in terms of transversals why this is so.

MINI 4WD

If two edges of the chassis are parallel and the axle crosses them, treat the axle as a transversal and match the corresponding angles. For a triangle you traced from the roller and the wall, show that the three angles meet in a straight line when you place three copies together. (Source: Ad Finem Liminis)

8.G.6 CC, CA, MI, NJ

Grade 8

STANDARD

Explain a proof of the Pythagorean Theorem and its converse.

MINI 4WD

At the right angle where the axle meets the motor shaft in Step 4, draw the right triangle those two lines make with a third side you measure. Explain why the Pythagorean relation holds for that triangle, and why the converse would tell you the angle is right if the side lengths satisfy it. (Source: Ad Finem Liminis)

8.G.7 CC, CA, MI, NJ, OH

Grade 8

STANDARD

Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions.

MINI 4WD

Measure the two legs of that right triangle on the chassis and find the unknown third side. If a roller sits above the chassis plane, use the three-dimensional form for the straight-line distance. (Source: Ad Finem Liminis)

8.G.8 CC, CA, MI, NJ, OH

Grade 8

STANDARD

Apply the Pythagorean Theorem to find the distance between two points in a coordinate system.

MINI 4WD

Assign coordinates to two points on the chassis, such as the motor mount and a roller. Use the Pythagorean relation to find the distance between them. (Source: Ad Finem Liminis)

8.G.9 CC, CA, MI, NJ

Grade 8

STANDARD

Know the formulas for the volumes of cones, cylinders, and spheres and use them to solve real-world and mathematical problems.

MINI 4WD

One cell and one wheel are cylinders. Measure the radius and height you need, and find each volume with the cylinder formula. Use a cone or sphere formula only for a part in front of you that has that shape. (Source: Ad Finem Liminis)

8.SP.1 CC, CA, MI, NJ

Grade 8

STANDARD

Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities. Describe patterns such as clustering, outliers, positive or negative association, linear association, and nonlinear association.

MINI 4WD

Plot car mass against heat time for several runs. Describe clusters, outliers, and whether the association is positive or negative, linear or not. (Source: Cursor)

8.SP.2 CC, CA, MI

Grade 8

STANDARD

Know that straight lines are widely used to model relationships between two quantitative variables. For scatter plots that suggest a linear association, informally fit a straight line, and informally assess the model fit by judging the closeness of the data points to the line.

MINI 4WD

If that plot suggests a line, fit one by eye. Judge the fit by how close the points sit to the line, and say where the line is a poor model. (Source: Cursor)

8.SP.3 CC, CA, MI, NJ

Grade 8

STANDARD

Use the equation of a linear model to solve problems in the context of bivariate measurement data, interpreting the slope and intercept. For example, in a linear model for a biology experiment, interpret a slope of 1.5 cm/hr as meaning that an additional hour of sunlight each day is associated with an additional 1.5 cm in mature plant height.

MINI 4WD

Write an equation for the line you fit. Interpret the slope as the change in heat time associated with one extra gram, and interpret the intercept in terms of a car whose added mass is zero. (Source: Cursor)

8.SP.4 CC, CA, MI, NJ, OH

Grade 8

STANDARD

Understand that patterns of association can also be seen in bivariate categorical data by displaying frequencies and relative frequencies in a two-way table. Construct and interpret a two-way table summarizing data on two categorical variables collected from the same subjects. Use relative frequencies calculated for rows or columns to describe possible association between the two variables. For example, collect data from students in your class on whether or not they have a curfew on school nights and whether or not they have assigned chores at home. Is there evidence that those who have a curfew also tend to have chores?

MINI 4WD

Make a two-way table of 3-lane track or 5-lane track against stayed in the lane or left it, for the same cars. Use the row or column shares to say whether the track and the outcome move together. (Source: Mini Manners)

Science

59 standards

Science · Grade 6 (preferred integrated)

19 standards

MS-LS1-1 NG, CA, MI, NJ, PA

Grade 6 (preferred integrated)

STANDARD

Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.

MINI 4WD

A thin slice of a plant leaf, seen through a microscope, is the evidence that a living thing is made of cells. A thin shaving of the car body is not. Look at both and say which one shows cells. (Source: Cursor)

MS-LS1-2 NG, CA, MI, NJ

Grade 6 (preferred integrated)

STANDARD

Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.

MINI 4WD

Draw a cell with its parts and the job of the whole cell. Beside it, draw the car with motor, gears, and wheels, and the job of the whole car. Same kind of drawing. Different kind of thing. (Source: Cursor)

MS-LS1-3 NG, CA, MI, NJ

Grade 6 (preferred integrated)

STANDARD

Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.

MINI 4WD

Argue from a body system, such as muscle and nerve letting a hand catch a car at the end of the lane. The car's motor, gears, and rollers are a machine system, not a body system. (Source: Cursor)

MS-LS1-4 NG, CA, MI, NJ

Grade 6 (preferred integrated)

STANDARD

Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.

MINI 4WD

A flower's shape and an animal's call change the chance of reproduction. Nothing the car does changes a chance of offspring. Read the living cases for this standard, and use the car only as the object that has no reproduction. (Source: Cursor)

MS-LS1-5 NG, CA, MI, NJ, PA

Grade 6 (preferred integrated)

STANDARD

Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.

MINI 4WD

Two plants of one kind, one starved of light and one not, show environment beside inheritance. Two cars of one kit, one left in heat until the tires change, show a condition acting on a made object. Report them as two explanations. (Source: Cursor)

MS-LS1-8 NG, CA, MI, NJ

Grade 6 (preferred integrated)

STANDARD

Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.

MINI 4WD

The eye sees the car drift and the hand corrects. That path is receptor, message, brain. The car's motor answers a switch, not a stimulus stored as a memory. (Source: Cursor)

MS-LS3-2 NG, CA, MI, NJ, PA

Grade 6 (preferred integrated)

STANDARD

Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.

MINI 4WD

A mold can press many matching bodies. That sameness is a copy, not asexual reproduction. Sexual reproduction's variation needs a living example. Say which diagram is which. (Source: Cursor)

MS-ESS2-4 NG, CA, MI, NJ, PA

Grade 6 (preferred integrated)

STANDARD

Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.

MINI 4WD

Draw water leaving a wet track, becoming vapor, then dripping back as rain, with the sun and gravity in the labels. The car is in the scene. It is not the cycle. (Source: Cursor)

MS-ESS2-5 NG, CA, MI

Grade 6 (preferred integrated)

STANDARD

Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.

MINI 4WD

On two race days, record temperature, wind, and cloud, and say what changed in the air between them. (Source: Cursor)

MS-ESS2-6 NG, CA, MI, NJ, PA

Grade 6 (preferred integrated)

STANDARD

Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.

MINI 4WD

A model of uneven sun and a spinning Earth is what this standard asks. A hot side and a cool side of a parked car in the sun is only a small picture of uneven heating, not of ocean currents. (Source: Cursor)

MS-ESS3-3 NG, CA, MI, NJ

Grade 6 (preferred integrated)

STANDARD

Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

MINI 4WD

Design a pit check that cuts one human mark on the place: cells packed out, oil kept off the soil, or broken plastic picked up. Say how you would know the mark got smaller. (Source: Cursor)

MS-ESS3-5 NG, CA, MI, PA

Grade 6 (preferred integrated)

STANDARD

Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

MINI 4WD

Ask which evidence is being used when someone says the air has warmed over the last century, and which of those questions a single hot race day cannot answer. (Source: Cursor)

MS-PS3-3 NG, CA, MI, NJ, PA

Grade 6 (preferred integrated)

STANDARD

Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.

MINI 4WD

Build a sleeve that slows how fast a motor can dump heat into the chassis, and a bare motor as the other case. Test which one keeps the can cooler for the same run. (Source: Cursor)

MS-PS3-4 NG, CA, MI, NJ, PA

Grade 6 (preferred integrated)

STANDARD

Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.

MINI 4WD

Plan a trial: same warming time, two masses of the same metal, or two metals of the same mass. Temperature is the measure. The car's motor can be the heater only if the plan says what is held still. (Source: Cursor)

MS-PS3-5 NG, CA, MI, NJ, PA

Grade 6 (preferred integrated)

STANDARD

Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.

MINI 4WD

When the car slows against a roller, its kinetic energy drops. Argue where that energy went: heat and sound at the contact, not "gone." (Source: Cursor)

MS-ETS1-1 NG, CA, MI, NJ, PA

Grade 6 (preferred integrated)

STANDARD

Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MINI 4WD

Write three tests a builder can check: the car stays between the walls, the car stays under the mass number you wrote, and the car uses only the parts you listed. Then write one way the car could bother the people beside the track, and one way it could bother the ground under the lane. (Source: Cursor)

Also printed in the grade 7 and grade 8 preferred-integrated documents.

MS-ETS1-2 NG, CA, MI, NJ, PA

Grade 6 (preferred integrated)

STANDARD

Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

MINI 4WD

Give both cars the same three checks, in the same order: stayed in the lane, crossed the finish, used only the listed parts. Count the checks each car passes. The higher count is the car that meets the problem. (Source: Cursor)

Also printed in the grade 7 and grade 8 preferred-integrated documents.

MS-ETS1-3 NG, CA, MI, NJ, PA

Grade 6 (preferred integrated)

STANDARD

Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

MINI 4WD

After both cars run, keep one part from the first car and one part from the second. Describe the third car that has both parts, and write the one test that third car still has to pass. (Source: Cursor)

Also printed in the grade 7 and grade 8 preferred-integrated documents.

MS-ETS1-4 NG, CA, MI, NJ, PA

Grade 6 (preferred integrated)

STANDARD

Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

MINI 4WD

Use one board, at one tilt, and let the car go the same way each time. Change only the roller, or only one added mass. Write the new time beside the old time. (Source: Cursor)

Also printed in the grade 7 and grade 8 preferred-integrated documents.

Science · Grade 7 (preferred integrated)

18 standards

MS-LS1-6 NG, CA, MI, NJ, PA

Grade 7 (preferred integrated)

STANDARD

Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.

MINI 4WD

Explain photosynthesis as the way light becomes stored chemical energy in a plant. If the cells were charged from a solar panel, that is a different device on the same sunlight. Do not call the panel a leaf. (Source: Cursor)

MS-LS1-7 NG, CA, MI, NJ, PA

Grade 7 (preferred integrated)

STANDARD

Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.

MINI 4WD

Model food being rearranged in a person who then lifts the car. The car does not rearrange food. The person's motion is the living side of the standard. (Source: Cursor)

MS-LS2-1 NG, CA, MI, NJ, PA

Grade 7 (preferred integrated)

STANDARD

Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

MINI 4WD

Fewer spare motors in the pit changes what the builders can run. Fewer plants in a plot changes what the animals can use. Read both as resource limits, and do not treat the motors as a population. (Source: Cursor)

MS-LS2-2 NG, CA, MI, NJ, PA

Grade 7 (preferred integrated)

STANDARD

Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

MINI 4WD

Predict one pattern between living things, such as a grazer and a plant, across two places. A faster car and a slower car on one track are opponents in a game, not that pattern. (Source: Cursor)

MS-LS2-3 NG, CA, MI, NJ, PA

Grade 7 (preferred integrated)

STANDARD

Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.

MINI 4WD

Draw matter and energy moving among plants, animals, and soil. On a second drawing, draw energy moving from cell to motor to heat. Label the second drawing as a machine, not an ecosystem. (Source: Cursor)

MS-LS2-4 NG, CA, MI, NJ, PA

Grade 7 (preferred integrated)

STANDARD

Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

MINI 4WD

Argue from evidence that changing one part of a living system changes who lives there. Changing the track surface changes which car setup finishes. Those are two arguments. (Source: Cursor)

MS-LS2-5 NG, CA, MI, NJ, PA

Grade 7 (preferred integrated)

STANDARD

Evaluate competing design solutions for maintaining biodiversity and ecosystem services.

MINI 4WD

Evaluate two real proposals for keeping a living place intact, using the published idea of the place. A rule that keeps oil off the club lot is a small human step, not a full biodiversity plan. (Source: Cursor)

MS-ESS2-1 NG, CA, MI, NJ, PA

Grade 7 (preferred integrated)

STANDARD

Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.

MINI 4WD

Model rock becoming sediment and sediment becoming rock, with heat or pressure in the labels. Plastic chassis pellets melted and remolded, if a teacher does that with proper heat, are a factory cycle, not the rock cycle. (Source: Cursor)

MS-ESS2-2 NG, CA, MI, NJ, PA

Grade 7 (preferred integrated)

STANDARD

Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.

MINI 4WD

Use a published before-and-after of a floodplain or a lava flow for the Earth process. One car scraping a clay bank is only a fast, tiny groove, useful as a scale comparison. (Source: Cursor)

MS-ESS2-3 NG, CA, MI, NJ

Grade 7 (preferred integrated)

STANDARD

Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.

MINI 4WD

The evidence is fossils, continent outlines, and seafloor maps. The car has no part in that evidence. The outline of the chassis can be traced only to practice reading a shape, then the maps are the actual work. (Source: Cursor)

MS-ESS3-1 NG, CA, MI, NJ, PA

Grade 7 (preferred integrated)

STANDARD

Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.

MINI 4WD

Explain, from a published source, why one region has oil, ore, or groundwater and another does not. The cells and the plastic in the car are products that came from some such region. (Source: Cursor)

MS-ESS3-2 NG, CA, MI, NJ, PA

Grade 7 (preferred integrated)

STANDARD

Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.

MINI 4WD

Read data on one hazard, such as flood or quake, and name a technology used to reduce harm. Say whether the club’s outdoor site sits in that hazard’s map. (Source: Cursor)

MS-PS1-1 NG, CA, MI, NJ, PA

Grade 7 (preferred integrated)

STANDARD

Develop models to describe the atomic composition of simple molecules and extended structures.

MINI 4WD

Model the repeating chain of a plastic and the simple molecule of water with drawings or kits. The car body is the bulk object made from the plastic’s units. (Source: Cursor)

MS-PS1-2 NG, CA, MI, NJ, PA

Grade 7 (preferred integrated)

STANDARD

Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.

MINI 4WD

Compare a tire before and after it is only washed, and a tablet before and after it dissolves in water. Say which case gives a new substance. (Source: Cursor)

MS-PS1-3 NG, CA, MI, NJ

Grade 7 (preferred integrated)

STANDARD

Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.

MINI 4WD

The body, the body latch, the tires, and the metal axles start as natural resources that were processed. Name the resource for one of them and one effect of making it. (Source: Cursor)

MS-PS1-4 NG, CA, MI, NJ

Grade 7 (preferred integrated)

STANDARD

Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

MINI 4WD

Heat water, then let it boil or freeze under a teacher's setup, and describe particle motion, temperature, and state. A motor can warming in the hand is a temperature change, not a change of state. (Source: Cursor)

MS-PS1-5 NG, CA, MI, NJ, PA

Grade 7 (preferred integrated)

STANDARD

Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.

MINI 4WD

Count atoms on paper for a simple reaction and show the count unchanged. Assembling the car conserves the parts you started with. That is a parts count, not a chemical equation. Use the equation for the standard. (Source: Cursor)

MS-PS1-6 NG, CA, MI, NJ, PA

Grade 7 (preferred integrated)

STANDARD

Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.

MINI 4WD

A hand-warmer pack or a dissolving salt that cools a cup is the chemical device. Use it under a teacher's plan. The car's cells are a different store. Do not open a cell. (Source: Cursor)

Science · Grade 8 (preferred integrated)

22 standards

MS-LS3-1 NG, CA, MI, NJ, PA

Grade 8 (preferred integrated)

STANDARD

Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.

MINI 4WD

A change in a gene can change a protein and then a body. A crack in a chassis changes how the car runs. Call the crack damage to a part, not a mutation. (Source: Cursor)

MS-LS4-1 NG, CA, MI, NJ, PA

Grade 8 (preferred integrated)

STANDARD

Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past.

MINI 4WD

The fossil record is the data: life appearing, changing, and disappearing in the rocks. Old car bodies in a cupboard are a hobby record. Use the fossil images for the pattern. (Source: Cursor)

MS-LS4-2 NG, CA, MI, NJ

Grade 8 (preferred integrated)

STANDARD

Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.

MINI 4WD

Similar bones in different animals are the evidence for relationship. Similar axle layouts in two kits are a shared design. Explain the bones. Mention the axles only as the look-alike that is not ancestry. (Source: Cursor)

MS-LS4-3 NG, CA, MI, NJ

Grade 8 (preferred integrated)

STANDARD

Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy.

MINI 4WD

Embryo drawings are the data for this standard. The car has no embryo. Do this one from the published plates. (Source: Cursor)

MS-LS4-4 NG, CA, MI, NJ, PA

Grade 8 (preferred integrated)

STANDARD

Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment.

MINI 4WD

Among living things, a heritable trait can raise the chance of living and reproducing in a place. Among cars, a setup can raise the chance of finishing on a track. The second case is not inherited and not reproduction. (Source: Cursor)

MS-LS4-5 NG, CA, MI, NJ, PA

Grade 8 (preferred integrated)

STANDARD

Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms.

MINI 4WD

Selective breeding and genetic tools change crops and animals. Choosing a gear set for a car is a builder's choice of parts. Name both, and do not call the gear set breeding. (Source: Cursor)

MS-LS4-6 NG, CA, MI, NJ, PA

Grade 8 (preferred integrated)

STANDARD

Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.

MINI 4WD

A published number example of a trait becoming more common is the mathematics. A lap chart of one car winning more often is a sports record, not natural selection. (Source: Cursor)

MS-ESS1-1 NG, CA, MI, NJ, PA

Grade 8 (preferred integrated)

STANDARD

Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.

MINI 4WD

Model Earth, the sun, and the moon with a lamp and two balls, and use that model for phases, eclipses, and seasons. A car on the table can stand in as a marker on the "ground," not as a planet. (Source: Cursor)

MS-ESS1-2 NG, CA, MI, NJ

Grade 8 (preferred integrated)

STANDARD

Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.

MINI 4WD

Gravity sets the orbits in the model of sun and planets. The car stays on the track because of forces from the ground and the walls, which is a different situation in the same topic of gravity's pull toward Earth. (Source: Cursor)

MS-ESS1-3 NG, CA, MI, NJ, PA

Grade 8 (preferred integrated)

STANDARD

Analyze and interpret data to determine scale properties of objects in the solar system.

MINI 4WD

Use published sizes and distances of sun, moon, and planets. Then place the car's length next to those numbers so the scale is felt. Do not invent a new astronomical size. (Source: Cursor)

MS-ESS1-4 NG, CA, MI, NJ, PA

Grade 8 (preferred integrated)

STANDARD

Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history.

MINI 4WD

Rock strata and the geologic time scale are the evidence, including the age the standard itself states. A layered stack of old decals is not strata. (Source: Cursor)

MS-ESS3-4 NG, CA, MI, NJ, PA

Grade 8 (preferred integrated)

STANDARD

Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

MINI 4WD

Argue from published figures of population and resource use. One club throwing away more plastic bodies is a small local example of consumption, not the global figure. (Source: Cursor)

MS-PS2-1 NG, CA, MI, NJ, PA

Grade 8 (preferred integrated)

STANDARD

Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.

MINI 4WD

When the car hits a wall, the wall pushes back as the car pushes on the wall. Design a roller so that pair of forces turns the car along the lane instead of stopping it dead. (Source: Cursor)

MS-PS2-2 NG, CA, MI, NJ, PA

Grade 8 (preferred integrated)

STANDARD

Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.

MINI 4WD

Plan a run that changes mass with a known added weight, motor off, same push, and record the change in motion. A second plan can change the push and hold the mass still. (Source: Cursor)

MS-PS2-3 NG, CA, MI, NJ, PA

Grade 8 (preferred integrated)

STANDARD

Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.

MINI 4WD

Ask which data change the pull: distance between a magnet and a steel axle, and whether the motor is off. The motor's magnetic field is the later, live case. Start with the magnet you can hold. (Source: Cursor)

MS-PS2-4 NG, CA, MI, NJ, PA

Grade 8 (preferred integrated)

STANDARD

Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.

MINI 4WD

Argue that the car and the Earth attract, which is why the car stays on the lane floor, and that a heavier car is pulled harder, which a scale can show. (Source: Cursor)

MS-PS2-5 NG, CA, MI, NJ, PA

Grade 8 (preferred integrated)

STANDARD

Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.

MINI 4WD

With parts not touching, a magnet still pulls a steel axle, and a charged balloon can pull a hair. Evaluate whether the test really kept them apart. The motor, unpowered, is not yet that test. (Source: Cursor)

MS-PS3-1 NG, CA, MI, NJ

Grade 8 (preferred integrated)

STANDARD

Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.

MINI 4WD

Graph kinetic energy against speed for one car, and against mass at one speed, from times over a measured lane. The shape of the graph is the point. (Source: Cursor)

MS-PS3-2 NG, CA, MI, NJ, PA

Grade 8 (preferred integrated)

STANDARD

Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.

MINI 4WD

A roller spring, or a car held at the top of a slope and then released, stores more energy in the raised or compressed arrangement than in the resting one. Model those two arrangements. (Source: Cursor)

MS-PS4-1 NG, CA, MI, NJ, PA

Grade 8 (preferred integrated)

STANDARD

Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.

MINI 4WD

On a string or a slinky, a larger shake carries more energy into a light panel. Relate that amplitude to the energy. The motor's buzz is a second, smaller example of a vibration, not the measurement model. (Source: Cursor)

MS-PS4-2 NG, CA, MI, NJ

Grade 8 (preferred integrated)

STANDARD

Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.

MINI 4WD

Light on the body can bounce, be taken up as heat, or pass a clear wing. Sort those three with a lamp. (Source: Cursor)

MS-PS4-3 NG, CA, MI, NJ, PA

Grade 8 (preferred integrated)

STANDARD

Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals.

MINI 4WD

A light that is either on or off to mean “go” is a digital signal. A shout that fades down the room is closer to analog. Say which one still means the same thing at the far end of the track. (Source: Cursor)

References

Engineering

NG Next Generation Science Standards · April 2013 · MS-ETS1-1 through MS-ETS1-4.

CA California State Board of Education · 4 September 2013 · Education Code 60605.85. The middle-school engineering text is the NGSS sentence.

FL Florida Department of Education · 2026–27 · Curriculum Framework for Integrated Technology Studies, Engineering & Technology Education. Exploration of Engineering Technology, course 8600060, Exploration of Robotics Technology, course 8600070, and Exploration of Technical Design Technology, course 8600090, and Exploration of Electronics Technology, course 8600091, and Exploration of Maritime Technology, course 8600092, and Exploration of Logistics and Supply Chain Technology, course 8600093, and Exploration of Green Construction and Architecture Technology, course 8600094, and Introduction to Technology, course 8600010, and Exploring Technology, course 8600020, and Exploration of Communications Technology, course 8600030, and Exploration of Production Technology, course 8600040, and Exploration of Aerospace Technology, course 8600050, and Exploration of Transportation Technology, course 8600240, and Exploration of Power and Energy Technology, course 8600250. These are the courses in program 8600000.

MI Michigan State Board of Education · 10 November 2015 · Michigan K-12 Science Standards. The middle-school engineering text is the NGSS sentence.

NJ New Jersey State Board of Education · 3 June 2020 · New Jersey Student Learning Standards – Computer Science and Design Thinking. On the shared card where the sentence matches. Computer Science by the end of grade 8, standard 8.1. Design Thinking by the end of grade 8 except Engineering Design, which is in the science book.

PA Pennsylvania State Board of Education · 13 January 2022 · Pennsylvania Technology and Engineering Standards. On the shared card where the sentence matches.

Language Arts

CC Common Core State Standards · 2 June 2010 · English Language Arts. National Governors Association Center for Best Practices and the Council of Chief State School Officers.

CA California State Board of Education · 2 August 2010 · California Common Core State Standards: English Language Arts and Literacy in History/Social Studies, Science, and Technical Subjects. Modified 13 March 2013.

MI Michigan State Board of Education · 15 June 2010 · Common Core State Standards for English Language Arts.

NJ New Jersey State Board of Education · 4 October 2023 · 2023 New Jersey Student Learning Standards: English Language Arts.

OH Ohio State Board of Education · February 2017 · Ohio's Learning Standards for English Language Arts.

PA Pennsylvania State Board of Education · 12 September 2013 · Pennsylvania Core Standards, English Language Arts. Effective 1 March 2014.

Mathematics

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CA California State Board of Education · 2 August 2010 · California Common Core State Standards: Mathematics. The published file includes January 2013 modifications and February 2014 corrections.

MI Michigan State Board of Education · 15 June 2010 · Common Core State Standards for Mathematics.

NJ New Jersey State Board of Education · 4 October 2023 · 2023 New Jersey Student Learning Standards: Mathematics.

OH Ohio State Board of Education · February 2017 · Ohio's Learning Standards for Mathematics.

Science

NG Next Generation Science Standards · April 2013

CA California State Board of Education · 4 September 2013 · Education Code 60605.85

MI Michigan State Board of Education · 10 November 2015 · Michigan K-12 Science Standards

NJ New Jersey State Board of Education · 3 June 2020 · New Jersey Student Learning Standards – Science; New Jersey Student Learning Standards – Computer Science and Design Thinking

PA Pennsylvania State Board of Education · 13 January 2022 · 22 Pa. Code Chapter 4

Sources

A card may name more than one source. Each name is counted once on every card that carries it.

Ad Finem Liminis

The parts book. Its pages name the chassis, axle, crown gear, bearing, motor, switch, battery, brake, and the step drawings.

Used 139 times.

Mini Manners

The race account. The car carries its own battery, there is no hand controller, the tires are solid, an 8-tooth pinion is the legal pinion, a 3-lane track and a 5-lane track are different, and the car that races is the car that was inspected.

Used 76 times.

Cursor

Written for the standard, with no sentence taken from the parts book or the race account.

Used 94 times.