Kenosha Unified School District

Monthly School Board Standing Committee Meeting

March 14, 2017

5:30 P.M. Curriculum/Program

Please Note: Committee meetings may start early if preceding meeting adjourns early.

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Kenosha Unified
School District

Standing Committee Meetings
March 14, 2017
Educational Support Center

I. **CURRICULUM/PROGRAM - 5:30 P.M.**

PLEASE NOTE: The March Planning/Facilities/Equipment, Personnel/Policy and Audit/Budget/Finance Standing Committee Meetings have been canceled

There may be a quorum of the board present at these Standing Committee meetings; however, under no circumstances will a board meeting be convened nor board action taken as part of the committee process. The three board members who have been appointed to each committee and the community advisors are the only voting members of the Standing Committees.

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KENOSHA UNIFIED SCHOOL BOARD
JOINT AUDIT/BUDGET/FINANCE AND
CURRICULUM/PROGRAM MEETING
Educational Support Center – Room 110
February 14, 2017
MINUTES

A joint meeting of the Kenosha Unified Audit/Budget/Finance and Curriculum/Program Committees chaired by Mr. Wade was called to order at 7:24 P.M. with the following Committee members present: Ms. Stevens, Mr. Battle, Mr. Holdorf, Mr. Leipski, Mr. Garcia, Mrs. Snyder, Mrs. Karabetsos, Dr. Werwie, and Mr. Wade. Dr. Savaglio-Jarvis was also present. Mr. Kunich, Mr. Aceto, and Mrs. Hamilton were excused. Mrs. Dawson, Mr. Kent, Mr. Balk, Mr. Potineni, Dr. Evans, Ms. Riese, and Mr. Ghouse were absent.

Mr. Wade noted that there was not a quorum present; therefore, no action could be taken.

Mary Frost Ashley Charitable Trust

Ms. Patricia Demos, Community School Relations Coordinator, presented the Mary Frost Ashley Charitable Trust. She explained that since 2010, the District has applied for and received funding from the Mary Frost Ashley Charitable Trust for back to school supplies, parent and student education and learning experiences, parent leadership training, the District's recognition program, annual Alcohol, Tobacco, and Other Drugs Awareness Student Recognition Brunch, as well as playground equipment for one elementary school. During the 2017-18 school year, the district plans to initiate several new programs to further develop and strengthen the comprehensive parent education training and family interactive learning experiences, expand student learning opportunities through support of high school student groups, strengthen the sustainability of the district's Recognition Program, and support the annual Alcohol, Tobacco and Other Drugs Awareness Student Recognition Brunch. Permission is requested to submit this one-year grant proposal titled Framework for Healthy Youth Development: Expanding Family Learning and Student Engagement Program in the amount of $117,125 to the Mary Frost Ashley Charitable Trust.

Mr. Wade indicated that no action could be taken on the Mary Frost Ashley Charitable Trust due to lack of a quorum and that the item would be forwarded to the full Board for action.

Meeting adjourned at 7:27 P.M.

Stacy Schroeder Busby
School Board Secretary

KENOSHA UNIFIED SCHOOL BOARD
CURRICULUM/PROGRAM MEETING
Educational Support Center – Room 110
February 14, 2017
MINUTES

A meeting of the Kenosha Unified Curriculum/Program Committee chaired by Mr. Wade was called to order at 7:27 P.M. with the following committee members present: Mr. Garcia, Mrs. Snyder, Mrs. Karabetsos, Dr. Werwie, and Mr. Wade. Dr. Savaglio-Jarvis was also present. Mrs. Hamilton was excused. Dr. Evans, Ms. Riese, and Mr. Ghouse were absent.

Approval of Minutes – January 10, 2017 Curriculum/Program
Mrs. Snyder moved to approve the minutes a contained in the agenda. Mr. Garcia seconded the motion. Unanimously approved.

Information Technology Course Change Proposal for LakeView Technology Academy
Ms. Julie Housaman, Chief Academic Officer, presented the Information Technology Course Change Proposal for LakeView Technology Academy. She noted that it has been determined that alternate courses should be proposed to shift the focus of the senior curriculum to favor programming over web development as that is the primary focus for LakeView. Approval is being sought for the removal of three courses formerly approved for the 2017-18 school year and the addition of two courses as detailed in the report.

Mrs. Snyder moved to forward the attached course proposals and course elimination requests for the Information Technology Curriculum at LakeView Technology Academy to the full School Board for consideration. Dr. Werwie seconded the motion. Unanimously approved.

Engineering Course Change Proposals for LakeView Technology Academy
Mrs. Housaman presented the Engineering Course Change Proposal for LakeView Technology Academy. She indicated that LakeView, under the guidance of Gateway Technical College, is proposing an update to the upper-level instructional program as well as some new courses that focus on computer numerical control (CNC) for the 2017-18 school year. With the proposed changes, engineering students, by the time of graduation, have the opportunity to earn a certificate as a mechanical maintenance technician, a certificate as a CNC operator, and be halfway through a certificate as an electromechanical maintenance technician. Approval is requested for the removal of the four courses and the addition of the five courses detailed in the report.

Mrs. Snyder moved to forward the course proposals and course elimination requests from LakeView Technology Academy to the full Board for consideration. Mr. Garcia seconded the motion. Unanimously approved.

New Course Proposal: Computer Science 2
Mrs. Housaman presented the New Course Proposal: Computer Science 2. She explained that in February 2016, the Board approved the addition of Computer Science Fundamentals for the middle schools. The introductory computer science curriculum has now been expanded to include Computer Science 2; therefore, approval is sought for the addition of this course to develop a second middle school elective course to provide additional opportunities for students to explore this growing career pathway. Due to space limitations on course

registration forms, Computer Science Fundamentals will be renamed Computer Science 1 and offered to students in seventh grade. A second middle school course, Computer Science 2, will be developed for grade 8. This course will provide an opportunity for students to go beyond the exploration and expression of their new skills to the innovation of design and the ability to analyze the impact of their design.

Mrs. Snyder moved to forward the proposal for the Addition of a Computer Science 2 course to the full Board for consideration. Mr. Garcia seconded the motion. Unanimously approved.

Information Item

Ms. Luanne Rohde, Director of Early Education, presented the Head Start Semi Annual Report. She noted that required Head Start performance standards for enrollment and health assessment requirements have been met; however, there was non-compliance noted in regards to the leadership and governance review. Measures have since been taken to address the areas of noncompliance. Ms. Rohde answered questions from Committee members.

Future Agenda Items

Mr. Wade indicated that the K-5 Science Materials, 9-12 World Language Materials, and Policy 6610 – Procedures and Selecting and Using Supplementary Materials would be presented in March.

Meeting adjourned at 7:39 P.M.

Stacy Schroeder Busby
School Board Secretary

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Kenosha Unified School District
Kenosha, Wisconsin

March 14, 2017
Personnel/Policy Standing Committee Meeting

POLICY 6610—PROCEDURES FOR SELECTING AND USING SUPPLEMENTARY INSTRUCTIONAL MATERIALS

Background

School Board Policy 6610 includes a seven-year curriculum cycle that details the selection and purchase of updated curriculum materials in Phase 3 of the seven-year cycle. To be responsive to the continuously changing global community and academic expectations and standards, it is essential that the curriculum cycle is reviewed regularly. When necessary, updates to this cycle are brought to the School Board for approval to ensure the immediate needs of students and teachers alike are addressed through this process.

The revisions to the seven-year cycle in Policy 6610 are based on maximizing curriculum funding allocations as well as the addition of early education and kindergarten through eighth grade Spanish language arts curriculum. The following chart indicates the year an update is made and the rationale for this change:

SEVEN-YEAR CURRICULUM REVIEW CYCLE UPDATES INCLUDING RATIONALE		
YEAR	**PHASE**	**RATIONALE**
2016-17	<u>Phase 1</u> Eliminate 9-12 science electives, and rename 11-12 science (fourth courses). Add K-8 Spanish language arts.	 Update verbiage to maintain consistency with other content areas. Vertical alignment of K-8 Spanish language arts will improve student outcomes in Spanish language proficiency.
	<u>Phase 3</u> Eliminate 3-5 social studies, and expand 3-5 science to K-5 science.	 Vendor pricing was more competitive when purchasing for K-5 as compared to a K-2 and

SEVEN-YEAR CURRICULUM REVIEW CYCLE UPDATES INCLUDING RATIONALE		
YEAR	**PHASE**	**RATIONALE**
	 Eliminate 9-12 social studies (Government, Psychology and electives), and add 6-12 social studies (U.S. History and Government).	then a 3-5 purchase the following school year. Potential realignment of 9-12 social studies courses is being considered to better align with Advanced Placement course offerings.
	Phase 4 Eliminate K-2 science and expand K-2 social studies to K-5 social studies.	 Vendor pricing was more competitive when purchasing for K-5 as compared to a K-2 and then a 3-5 purchase the following school year.
2017-18	Phase 1 Eliminate 6-8 social studies, and add 6-12 social studies (U.S. History/ Government).	 Expand curriculum development from grades 9-12 to grades 6-12 to support vertical alignment of U.S. History and Government courses.
2018-19	Phase 1 Add early education curriculum. Add 9-12 social studies electives.	 Early education curriculum was inadvertently not included in the original policy. Begin curriculum review process of final secondary social studies elective courses.

SEVEN-YEAR CURRICULUM REVIEW CYCLE UPDATES INCLUDING RATIONALE		
YEAR	**PHASE**	**RATIONALE**
	Add 6-8 world language.	In 2012-2013 Rosetta Stone was purchased to supplement the 6-8 World Language resources. A complete curriculum review process for middle school will begin in the fall of 2018.

Recommendation

Administration recommends that the Personnel/Policy Standing Committee forward the revised Kenosha Unified School District Policy 6610—Procedures for Selecting and Using Supplementary Instructional Materials—to the board of education for approval as a first reading at the March 28, 2017, meeting and second reading on April 24, 2017.

Dr. Sue Savaglio-Jarvis
Superintendent of Schools

Ms. Julie Housaman
Chief Academic Officer

Mr. Che Kearby
Coordinator of Educator Effectiveness and Social Studies

Ms. Christine Pratt
Coordinator of Science

Ms. Sarah Smith
Coordinator of Language Acquisition

Ms. Luanne Rohde
Director of Early Education

POLICY 6610
SELECTION OF INSTRUCTIONAL MATERIALS

The selection of instructional materials, including required textbooks and supplementary books and materials, shall be recommended to the School Board by the Superintendent of Schools, in accordance with District rules and regulations. The Board shall make the final determination regarding selection of materials.

Textbooks and other materials which are required to be read by all students shall be evaluated and recommended to the Superintendent by the Assistant Superintendent of Teaching and Learning and the curriculum design team. This team is charged with the responsibility of screening materials and preparing recommendations for selection and adoption of instructional materials.

Supplementary materials which are to be used for particular programs in individual schools may be selected by teachers, teacher committees or departments with the approval of the principal, the Assistant Superintendent of Teaching and Learning, and the Superintendent/designee.

The Board shall adopt the required textbooks for the District**.**

The District shall not discriminate in the selection and evaluation of instructional and library materials or media on the basis of sex, race, religion, national origin, ancestry, creed, pregnancy, marital or parental status, sexual orientation, physical, mental, emotional or learning disability or handicap. Discrimination complaints shall be processed in accordance with established procedures.

LEGAL REF.: Wisconsin Statutes
Sections 118.03(2) [Purchase of textbooks]
118.13 ~~[Student~~ **Pupil** discrimination prohibited~~]~~
120.10(15) ~~[Annual meeting power; authorize school to furnish t~~**T**extbooks~~]~~
120.12(11) ~~[Board duty; provision of books and supplies to i~~**I**ndigent ~~students~~ **children**~~]~~
120.13 ~~[~~**School** ~~B~~**b**oard power**s** ~~to do all things reasonable for cause of education]~~
120.13(5) ~~[Board power to purchase b~~**B**ooks, **material and** equipment ~~and materials for use in schools]~~
~~121.02(1)(h) [Instructional materials standard]~~
Wisconsin Administrative Code
PI 9.03(1) [~~Nondiscrimination statement required in instructional materials selection/evaluation policy~~**Prohibiting discrimination against pupils**]

CROSS REF.: 1410, Free Materials
2110, Benchmarks
3280, Student Fees
5110, Equal Educational Opportuniti~~es~~**y**/Discrimination Complaint
6300, Curriculum Development and Improvement
6430, Instructional Arrangements (The Learning Situation)
6620, Library Resources
6810, Teaching ~~a~~**A**bout Controversial Issues
Board-Adopted Academic Standards
~~District Learning and Content Standards~~

AFFIRMED: September 24, 1991

REVISED: March 9, 1999
January 29, 2002
December 15, 2015
April 24, 2017

RULE 6610
PROCEDURES FOR SELECTING AND USING
SUPPLEMENTARY INSTRUCTIONAL MATERIALS

1. No student shall be required to read supplementary books~~,~~ or those on a required list~~,~~ if the parent/guardian indicates there are reasons why a particular book should not be read by their child.
2. Movies/video clips can enhance the educational experience for students. Therefore, movies/videos must be directly relevant to the curriculum and be appropriate for all students within the classroom. Following careful evaluation, movies/video clips in various formats and other audio-visual materials may be used for instructional purposes in accordance with District Policy 3531.1—Copyrighted Materials.
3. Movies/video clips are defined as being less than 25 minutes in length and are to be used with classroom discussion or activities.
4. Commercial entertainment videos having obvious educational value may be included when appropriate to the subject being studied. Commercial videos that are unrated or rated PG or PG-13 shall not be shown to students in the District without advance written notice to the parents. Such notice shall contain an accurate description of the contents of the film. No videos having an R, NC-17, or X shall be shown to students at any school.
5. Parents/guardians not wishing to have their children participate in viewing a particular video may indicate this decision in a note to the principal. The decision of the parent/guardian will be respected**,** and an assignment of equal value may be given as an alternative to attending the showing of such a video. The parent/guardian shall be given an opportunity to review District-owned audio-visual materials as available~~,~~ at no additional expense to the District.

RULE 6610
PROCEDURES FOR SELECTING AND USING
SUPPLEMENTARY INSTRUCTIONAL MATERIALS

SEVEN-YEAR CURICULUM REVIEW CYCLE

SCHOOL YEAR	**PHASE 1: REVIEW**	**PHASE 2: DEVELOP**	**PHASE 3: PREPARE**	**PHASE 4: IMPLEMENT**	**PHASE 5: MONITOR**		
	Year 1—How does what we are doing now correlate with the research?	Year 2—What are we going to do?	Year 3—How are we going to do it?	Year 4—What does it look like in the classroom?	Year 5—How will we know we accomplished what we intended?	Year 6—How well is it working, and how can we make it better?	Year 7—Is what we set out to do happening—are students learning?
2016-17	• K-5 math • ~~9-12 science electives~~ • **11-12 science (fourth courses)** • K-12 art • 9-12 career and technical education (business and family and consumer science) • **K-8 Spanish language arts (dual language)**	• ~~9~~**6**-12 social studies (World History) • K-12 health • 6-12 theatre • 6-11 science	• ~~3~~**K**-5 science • ~~3-5 social studies~~ • ~~9-12 social studies (U.S. History)~~ • 9-12 career and technical education (Exploring Health Occupations) • 9-12 world languages	• 11-12 math (fourth courses) • ~~K-2 science~~ • K-~~2~~**5** social studies • 9-12 English Language Development III	• K-5 reading • 6-12 English • K-12 English Language Development I/II	• 6-10 math	

SCHOOL YEAR	PHASE 1: REVIEW	PHASE 2: DEVELOP	PHASE 3: PREPARE	PHASE 4: IMPLEMENT	PHASE 5: MONITOR		
2017-18	• ~~6-8 social studies~~ • ~~9~~6-12 social studies (U.S. **History/** Government~~,~~ ~~Psychology, and electives~~) • 4-12 performance music • Career and technical education (technology)	• K-5 math • ~~9-12 science electives~~ • **11-12 science (fourth courses)** • K-12 art • 9-12 career and technical education (business and family and consumer science) • **K-8 Spanish language arts (dual language)**	• ~~9~~6-12 social studies (World History) • K-12 health • 6-12 theatre • 6-11 science	• ~~3~~**K**-5 science • ~~3-5 social studies~~ • ~~9-12 social studies (U.S. History)~~ • 9-12 career and technical education (Exploring Health Occupations) • 9-12 world languages	• 11-12 math (fourth courses • ~~K-2 science~~ • K-~~2~~ **5**social studies • 9-12 English Language Development III	• K-5 reading • 6-12 English • K-12 English Language Development I/II	• 6-10 math
2018-19	• 6-10 math • K-5 music • **Early education** • **9-12 social studies electives** • **6-8 world language**	• ~~6-8 social studies~~ • ~~9~~6-12 social studies (U.S. **History/** Government~~,~~ ~~Psychology, and electives~~) • 4-12 performance music • Career and technical education (technology)	• K-5 math • ~~9-12 science electives~~ • **11-12 science (fourth courses)** • K-12 art • 9-12 career and technical education (business and family and consumer science) • **K-8 Spanish language arts**	• ~~9~~6-12 social studies (World History) • K-12 health • 6-11 theatre • 6-11 science	• ~~3~~**K**-5 science • ~~3-5 social studies~~ • ~~9-12 social studies (U.S. History)~~ • 9-12 career and technical education (Exploring Health Occupations) • 9-12 world languages	• 11-12 math (fourth courses) • ~~K-2 science~~ • K-~~2~~**5** social studies • 9-12 English Language Development III	• K-5 reading • 6-12 English • K-12 English Language Development I/II

SCHOOL YEAR	PHASE 1: REVIEW	PHASE 2: DEVELOP	PHASE 3: PREPARE	PHASE 4: IMPLEMENT	PHASE 5: MONITOR		
			(dual language)				
2019-20	• K-12 English language arts • K-12 English Language Development I/II • K-12 physical education	• 6-10 math • K-5 music • **Early education** • **9-12 social studies electives** • **6-8 world language**	• ~~6-8 social studies~~ • ~~9~~**6**-12 social studies (U.S. **History/** Government~~,~~ ~~Psychology, and electives~~) • 6-12 choir, orchestra, and band • Career and technical education (technology)	• K-5 math • ~~9-12 science electives~~ • **11-12 science (fourth courses)** • K-12 art • 9-12 career and technical education (business and family and consumer science) • **K-8 Spanish language arts (dual language)**	• **6-12 social studies (World History)** • **K-12 health** • 6-12 theatre • 6-11 science • ~~9-12 social studies (World History)~~ • ~~K-12 health~~	• ~~3~~**K**-5 science • ~~3-5 social studies~~ • ~~9-12 social studies (U.S. History)~~ • 9-12 career and technical education (Exploring Health Occupations) • 9-12 world languages	• 11-12 math (fourth courses) • ~~K-2 science~~ • K-~~2~~**5** social studies • 9-12 English Language Development III • World languages

SCHOOL YEAR	PHASE 1: REVIEW	PHASE 2: DEVELOP	PHASE 3: PREPARE	PHASE 4: IMPLEMENT	PHASE 5: MONITOR		
2020-21		• K-12 English language arts • K-12 English Language Development I/II • K-12 physical education	• 6-10 math • K-5 music • **Early education** • **9-12 social studies electives** • **6-8 world language**	• ~~6-8 social studies~~ • ~~9~~**6**-12 social studies (U.S. **History/** Government~~,~~ ~~psychology, and electives~~) • 6-12 choir, orchestra, and band • Career and technical education (technology)	• K-5 math • ~~9-12 science electives~~ • **11-12 science (fourth courses)** • K-12 art • 9-12 career and technical education (business and family and consumer science) • **K-8 Spanish language arts (dual language)**	• **6-12 social studies (World History)** • **K-12 health** • 6-12 theatre • 6-11 science • ~~9-12 social studies (World History)~~ • ~~K-12 health~~	• ~~3~~**K**-5 science • ~~3-5 social studies~~ • ~~9-12 social studies (U.S. History)~~ • 9-12 math (Financial Algebra) • Career and technical education (Exploring Health Occupations) • 9-12 world languages

Throughout 2016-21 the Curriculum Review Cycle may need to be amended due to state and district curriculum and assessment guidelines and revisions.

KENOSHA UNIFIED SCHOOL DISTRICT
Kenosha, Wisconsin

March 14, 2017
Curriculum/Program Standing Committee Meeting

ADOPTION OF INSTRUCTIONAL MATERIALS FOR NINTH THROUGH TWELFTH GRADE WORLD LANGUAGE

Background

The world language program in Kenosha Unified School District consists of five languages: Chinese, French, German, Italian, and Spanish. The high school world language program offers a variety of these five languages at various high schools as shown in the chart below.

HIGH SCHOOL	WORLD LANGUAGE OPTIONS
Bradford	• Italian • Spanish • Spanish for Spanish Speakers
Harborside	• Spanish
Indian Trail	• Chinese • French • Spanish • Spanish for Spanish Speakers
Tremper	• French • Spanish • Spanish for Spanish Speakers
Kenosha eSchool	• Chinese • French • German • Italian • Spanish

The last purchase of materials for high school world language was in 2010, when materials were purchased for Chinese, French, German, Italian, and Spanish.

Rationale for Curriculum Update

World language teachers have expressed the need for updates to the current curriculum and updated resources. With updates to technology in the past ten years, there are many interactive pieces that can be used for the curriculum, including new instructional approaches and classroom resources.

Phase 1 of the curriculum review process (Appendix A) for world language began in September 2013. A thorough analysis of current enrollment, student performance, and current instructional trends in world languages ensued (Appendix B).

In Phase 2 curriculum design team members (Appendix C) identified units of study, aligned the written and tested curriculum, and designed the assessment tools.

In the finals stages, team members working in groups by specific world languages (i.e., Chinese, French, German, Italian, and Spanish) reviewed existing resources to determine what, if any, gaps existed. At this time, German and Chinese teachers determined that the current curriculum resources would continue to effectively support the updates to the curriculum units.

French, Italian, and Spanish curriculum design teams moved into Phase 3 of the curriculum development cycle. Design team members reviewed textbooks, leveled readers, and various other resources related to their respective languages. The French curriculum design team chose a variety of leveled readers that paired with each of the levels of French language instruction. The Spanish curriculum design team selected an online resource and leveled readers to guide the Spanish language acquisition process. Chromebooks and carts are recommended for purchase for Chinese, French, Italian, and Spanish to support online resources, culturally relevant language instruction, and preparation for Advanced Placement exams.

The following curriculum resources were selected:

LANGUAGE	**INSTRUCTIONAL RESOURCES**	**TECHNOLOGY**
Chinese	NA	Chromebooks
French	Leveled readers	Chromebooks
German	NA	Chromebooks are not needed for the Kenosha eSchool on-line curriculum
Italian	NA	Chromebooks
Spanish	*Somos* by Martina Bex Leveled readers	Chromebooks

INSTRUCTIONAL MATERIALS

Appendix D provides a list of instructional materials.

NEW MATERIAL BENEFITS

- Updated instructional resources to enhance world language curriculum

- Use of Teaching Proficiency Through Reading and Storytelling (TPRS) methodology, an approach to language learning allowing students to play an active role in the language acquisition process

- Access to technology for cultural and communication projects in the target language

- Common leveled readers base aligned to world language standards and American Council on the Teaching of Foreign Languages language levels

- Access to a larger variety of novels for student voluntary reading

Implementation

The instructional materials selected to support the Kenosha Unified School District world language curriculum would be put into place for the start of the 2017-18 school year.

Planning is in progress for the following professional learning sessions:

PROFESSIONAL DEVELOPMENT WORKSHOPS IN SUMMER 2017 AND BEYOND			
Date	**Topic**	**Audience**	**Provider**
August 30, 2017	TPRS in upper level language classes	High school Spanish world language teachers	Bryce Hedstrom Comprehensible Input and TPRS consultant
Fall 2017	Establishing meaning in multisensory and comprehensible ways	World language teachers	Haiyun Lu Comprehensible Input consultant
Spring 2017	Reading strategies, differentiation, class activities, and assessment design	World language teachers	Haiyun Lu Comprehensible Input consultant

High school world language will begin Phase 4 of the curriculum development process in September 2017. Throughout the school year, the coordinator of language acquisition will work with teachers and principals to monitor the impact of the instructional resources. The Phase 4 work will include:

- Assessing student progress using assessments embedded in the program
- Planning and activating the ongoing program evaluation design
- Collecting teacher feedback

Recommendation

Administration recommends that the Curriculum/Program Standing committee forward the recommendation to purchase Spanish and French instructional resources along with Chromebooks and Chromebook carts to the full Board of Education on March 28, 2017.

Dr. Sue Savaglio-Jarvis
Superintendent of Schools

Mrs. Julie Housaman
Chief Academic Officer

Mrs. Sarah Smith
Coordinator of Language Acquisition

POLICY 6300
CURRICULUM DEVELOPMENT AND IMPROVEMENT

A prekindergarten through twelfth grade curriculum shall be established and maintained in accordance with state law, the needs of society, the local community, and the individual student.

The District's academic content standards adopted by the School Board shall serve as the basis for all curriculum and instructional program development in the District.

A cyclical curriculum development process for all fields of study will provide a comprehensive evaluation of course content, an inclusive curriculum development process, a thoughtful implementation, revisions based on data, and time for program effectiveness to be realized. The cyclical curriculum development process includes five phases encompassing seven years of work. In Phase 3 the curriculum design team will determine the curriculum resources and professional learning needs that are critical to advance the curriculum development process to Phase 4. A budget assumption will be brought to the school board for approval annually during Phase 3.

Recommendation for additions or deletions to the established curriculum shall be reviewed by the Assistant Superintendent of Teaching and Learning and provided to the Superintendent of Schools and School Board for approval.

LEGAL REF: Wisconsin Statutes
Sections 118.01 (Instructional program goal requirements)
118.30 (Academic standards and assessment requirements)
120.13 (Board power to do all things reasonable for the cause of education)
121.02(1)(k) &(L) (Rules implementing curriculum state standard)
Wisconsin Administrative Code
PI 8.01(2)(k) & (l) Rules implementing curriculum program standards

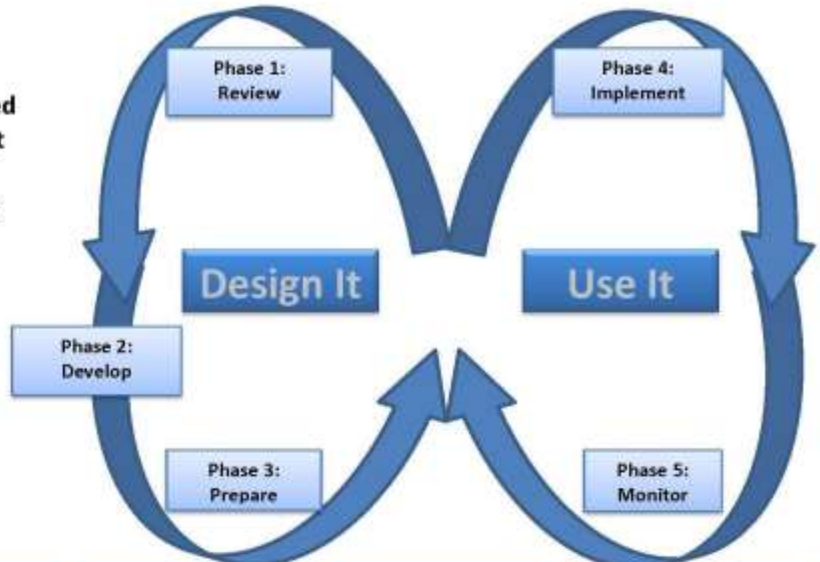
CROSS REF: 6100, Mission, Vision, Core Values and Strategic Directions
6310, Elementary School Curriculum
6610, Selection of Instructional Materials
6620, Library Resources
Board-Adopted Academic Standards
District Learning and Content Standards

AFFIRMED: September 24, 1991

REVISED: November 8, 1994
October 13, 1998
January 29, 2002
December 20, 2011
June 25, 2013
December 15, 2015

RULE 6300
CURRICULUM DEVELOPMENT AND IMPROVEMENT

Kenosha Unified School District
Curriculum Development Cycle



Phase 1: Review	Phase 2: Develop	Phase 3: Prepare	Phase 4: Implement	Phase 5: Monitor
• Review Curriculum Audit • Analyze assessments • Study current trends • Affirm philosophy • Deconstruct standards • Create scope and sequence	• Determine units of study • Align written and tested curriculum • Create assessment tools • Complete curriculum guides • Determine resource and professional learning needs	• Gather feedback from focus groups • Recommend and purchase resources pending BOE approval • Plan professional learning	• Deliver professional learning and monitor impact • Assess student progress • Plan and activate program evaluation • Collect feedback	• Analyze student work • Analyze assessment results • Review data • Update curriculum guides • Continue professional learning • Evaluate improvemnts

Kenosha Unified School District

WORLD LANGUAGE CURRICULUM DEVELOPMENT TIMELINE
JANUARY 2017

TIME FRAME	CURRICULUM DEVELOPMENT PHASE	ACTIVITY	DESCRIPTION OF ACTIVITY	OUTCOME
September 2013 to February 2014	Phase 1	Initial review	Initial observations of world language program at individual building sites	Assessed current high school world language program
Spring 2014	Phase 1	Initial needs assessment with world language teachers and administrators	Meeting with superintendent, chief academic officer, and world language teachers	Prioritized a list of needs
Summer 2014	Phase 1	Reviewed curriculum audit, studied current trends, began scope and sequences	Initial meeting with department chair and leaders to align world language curriculum for Levels 1, 2, 3, and Advance Placement, presentation of findings from curriculum audit Solidified dates for future work	Reviewed and prioritized needs, reviewed curriculum audit, and set dates for initial language alignment work
2014-15 school year	Phase 1	Deconstructed standards	Reviewed the national world language standards and began the curriculum design process	Aligned standards with overall themes in all language areas

TIME FRAME	CURRICULUM DEVELOPMENT PHASE	ACTIVITY	DESCRIPTION OF ACTIVITY	OUTCOME
Summer 2015	Phase 2	Aligned written and tested curriculum	Determined key themes and units of study	Created units based on research of best instructional practices in world language classroom settings
2015-16 school year	Phase 2	Determined resources and professional learning needs of language groups	Adjusted curriculum and followed recommendations of partner-language colleagues and reviewed language learning resources	Decided on recommendations for instructional materials
2016-17 school year	Phase 3	Finalized curriculum work for French and Spanish	Continue to meet to align existing instructional resources to the curriculum and select additional materials if needed	Recommended leveled novels for use in French and Spanish classrooms Recommended Chromebooks for use in Chinese, French, Italian, and Spanish classrooms

Kenosha Unified School District

WORLD LANGUAGE INSTRUCTIONAL RESOURCE REVIEW COMMITTEE

LAST NAME	FIRST NAME	LOCATION
Antczak	Sarah	Indian Trail High School and Academy
Belanger-Gonzales	Lee	Bradford High School
Carbajal	Jean	Bullen Middle School
Chase	Julie	Tremper High School
Droessler	Lisa	Indian Trail High School and Academy
Hessenthaler	Chera	Indian Trail High School and Academy
Hsiao	Sandra	Indian Trail High School and Academy
Ishmael	Michelle	Kenosha eSchool
King	Christine	Indian Trail High School and Academy
Kuel	Ashley	Harborside Academy
Laurent	Jeffrey	Indian Trail High School and Academy
Moore	Katie	Tremper High School
Notarianni	Patrizia	Tremper High School
Padlock	Colleen	Tremper
Peregrini	Nelly	Tremper
Simmons	Elizabeth	Indian Trail High School and Academy
Smith	Sarah	Office of Language Acquisition
Tovar	Olga	Bradford High School
Towers	Mary	Mahone Middle School
Ziccarelli	Marianne	Tremper High School

Kenosha Unified School District

WORLD LANGUAGE RECOMMENDATIONS

Instructional Materials

MARTINA BEX			
Location	**Class**	**Materials**	**Cost**
Bradford High School	• Spanish	• Licenses for supplementary Spanish curriculum	$1,000
Indian Trail High School And Academy	• Spanish	• Licenses for supplementary Spanish curriculum	$2,000
Tremper High School	• Spanish	• Licenses for supplementary Spanish curriculum	$1,000
Harborside Academy	• Spanish	• Licenses for supplementary Spanish curriculum	$250
TOTAL			**$4,250**

TEACHING PROFICIENCY THROUGH READING AND STORYTELLING			
Location	**Class**	**Materials**	**Cost**
Bradford High School	• Spanish	• Leveled readers	$5,025
Indian Trail High School And Academy	• Spanish	• Leveled readers	$7,550
Indian Trail High School And Academy	• French	• Leveled readers	$1,525
Tremper High School	• Spanish	• Leveled readers	$6,000
Tremper High School	• French	• Leveled readers	$1,925
Harborside Academy	• Spanish	• Leveled readers	$2,275
TOTAL			**$24,300**

Professional Learning

Location	Class	Materials	Cost
Professional Learning	• Spanish teachers	• Consultant to train Spanish teachers on instructional strategy	$6,000
TOTAL			**$6,000**

Technology

LOCATION	CLASS	MATERIALS	COST
Bradford High School	• Italian • Spanish	• Chromebooks • Cart • Headphones	$11,500
Indian Trail High School And Academy	• Chinese • French • Spanish	• Chromebooks • Cart • Headphones	$23,000
Tremper High School	• French • Spanish	• Chromebooks • Cart • Headphones	$11,500
Harborside Academy	• Spanish	• Chromebooks • Cart • Headphones	$11,500
TOTAL			**$57,500**[*]

[*] A request to purchase document is not required because the district already has a contract in place through Information Services with Paragon, the provider of the Chromebooks and Chromebook carts.

KENOSHA UNIFIED SCHOOL DISTRICT
Kenosha, Wisconsin

March 14, 2017
Curriculum/Program Standing Committee Meeting

ADOPTION OF INSTRUCTIONAL MATERIALS FOR KINDERGARTEN THROUGH FIFTH GRADE SCIENCE

Background

The Kenosha Unified School District Board of Education was provided updates on the national release of new science standards, known as the Next Generation Science Standards (NGSS), in July and November 2013. A Kenosha Unified School District Science Curriculum Committee was created to conduct an in-depth review of the new standards. The committee met seven times from January through May 2014. In June 2014 the Office of Teaching and Learning brought a recommendation to adopt the NGSS to the Board of Education. The recommendation was approved unanimously at the June 24, 2014, Board of Education Meeting; and the work of implementing the new standards began.

On May 12, 2015, an update on implementation goals and accomplishments aligned with the Curriculum Audit Recommendations was shared with the Curriculum/Program Standing Committee of the Board of Education. The following points were listed in the implementation update as goals and next steps:

- Reconvene the Kenosha Unified School District Science Curriculum Committee, and add any additional interested staff to begin a thorough review of new instructional resources based on the NGSS as released by publishers.

- Develop a plan, including projected budget amounts, for obtaining and implementing high quality NGSS-based instructional resources as appropriate based on availability.

- Bring a budget assumption recommendation to the Board of Education for approval.

Philosophical Statement for Science

Kenosha Unified School District science teachers believe that all students must have high quality opportunities to learn the practices, core ideas, and concepts of science from early childhood education through graduation. Science instruction must integrate technology, mathematics, and engineering.

Effective instruction in the practices, core ideas, and concepts of science provides students with sufficient skills and knowledge to:

- Demonstrate success in the classroom.
- Appreciate the significance and usefulness of science.
- Gather information using scientific processes.
- Use critical reasoning to construct explanations and solve problems.
- Communicate findings and solutions through speaking, writing, and creating presentations.

In order to achieve success with the practices, core ideas, and concepts of science, Kenosha Unified School District science students will engage in collaborative, inquiry-based investigations through questioning, modeling, analyzing data, applying mathematics, solving problems, and constructing evidence-based explanations.

Students will graduate ready to continue learning beyond the school setting, enter careers of their choice, and engage in public discussions of science related issues.

Rationale for Curriculum Update

This request to adopt and purchase science instructional materials for kindergarten through fifth grade aligns with Phase 3 of the Curriculum Development Cycle in Kenosha Unified School District Board of Education Policy 6300: Curriculum Development and Improvement (Appendix A).

Instructional Materials Review Process

The instructional materials review process began in February 2016. An Elementary Science Instructional Materials Review Team (Appendix B) met six times from February 2016 through July 2016. They accomplished the following tasks:

- Reviewed and revised the Kenosha Unified School District Philosophical Statement for Science
- Examined the current state of elementary science curriculum and instruction and developed a list of priorities to consider when searching for elementary science instructional resources

  Priorities included:

  - Aligned to the NGSS

    - Grounded in hands-on inquiry- and engineering-based activities with materials provided by the district

    - Allowed for logical progressions of concepts and skills from grade to grade

- Used the list of priorities to review an extensive and comprehensive list of elementary science instructional materials

- Selected seven instructional programs to review in depth

The team members also worked to increase their understanding of the NGSS and the instructional shifts required to successfully implement them by attending the following professional learning opportunities:

- February 5, 2016—A workshop presented by Wisconsin Education Innovations titled: What the Next Generation Science Standards Look Like in the Classroom

- March 30, 2016 through April 3, 2016—The National Science Teachers Association's Conference on Science Education

- April 21 through 23, 2016—The Wisconsin Society of Science Teacher's Conference.

Team members who attended the professional learning opportunities also conducted research on the availability of instructional resources aligned to the NGSS.

Representatives from each of the seven instructional programs chosen for in-depth review were invited to present their program to the members of the Elementary Science Instructional Materials Review Team. These presentations occurred between September 2016 and January 2017. The team used a Vendor Presentation Review and Feedback form to gather information and submit comments (Appendix C). After all presentations were complete, the team met twice to analyze its findings using the Wisconsin Instructional Resources Review Tool for Science (Appendix D). As a result of these meetings, the team chose two finalists.

Instructional materials and resources from both finalists were on display at the Educational Support Center from February 1 through 10, 2017. Instructional staff and community members were invited, via the Kenosha Unified School District media outlets, website, and the Kenosha News, to peruse the materials and provide feedback (Appendix E).

As a result of the in-depth review process described in this report, *Amplify Science* was selected as the core instructional program for Kenosha Unified School District kindergarten through grade 5 science. The new Amplify science curriculum is based on the Next Generation Science Standards. It was developed through a partnership between the Lawrence Hall of Science, a public science museum and research center at the University of California—Berkeley, and Amplify, a digital educational products company. The Amplify science curriculum blends digital experiences with hands-on lessons, and the units have been extensively field-tested. It is currently in use in over 55 districts in the United States, including districts in Wisconsin, California, New Jersey, and Pennsylvania.

INSTRUCTIONAL MATERIALS

The Purchase/Contract Rationale form includes a list of teacher resources and instructional materials (Appendix F).

NEW MATERIAL BENEFITS

- *Amplify Science* is a new generation science curriculum that connects science instruction to literacy and math standards and engineering concepts.
- *Amplify Science* was written from the ground up to align with the NGSS. It addresses 100 percent of the standards.
- *Amplify Science* uses a pedagogy that invites students to explore phenomena with the purpose of solving authentic problems (sample teacher resources in Appendix G).
- The teacher resources for each unit list assume prior knowledge and experience. This is especially helpful for planning prekindergarten instruction to ensure students enter kindergarten with appropriate foundational experiences.
- Students are inspired to read, write, and argue like scientists and design solutions like engineers (sample lesson in Appendix H).
- The program's mission is to help educators create the next generation of scientific innovators as well as citizens who are skeptical, curious, and evidence-based thinkers.
- Teachers will receive a complete and ready-to-use curriculum with detailed lesson plans, embedded formative assessments, hands-on kits and manipulatives, digital simulations, and a variety of effective teacher supports.

Implementation

Purchase of the kindergarten through fifth grade *Amplify Science* curriculum in April 2016 will allow teachers on-line access to materials before leaving for the summer.

Planning is in progress for the following professional learning sessions:

DATE	TOPIC	AUDIENCE	PROVIDER
June-August 2017	Grade level workshops, NGSS and the Amplify philosophy, connecting Unit 1 to the grade level curriculum	Kindergarten-grade 5 teachers and administrators	Science coordinator, Teaching and Learning staff, Amplify staff
August 2017	Mandatory professional learning using the program and background knowledge for Unit 1	Kindergarten-grade 5 teachers and administrators	Science coordinator, Teaching and Learning staff, Amplify staff
September 2017	Workshops using the program and background knowledge for Unit 1	English-as-a-second-language teachers and special education teachers	Science coordinator and Amplify staff
September 2017-April 2018	Friday professional learning and workshop opportunities: background knowledge and pedagogy for remaining units	Elementary instructional staff and administrators	Science coordinator and Amplify staff
Summer 2018	Grade level workshops: connections to grade level curriculum	Elementary instructional staff and administrators	Science coordinator and Amplify staff

Kindergarten through fifth grade science will begin Phase 4 of the curriculum development process in September 2017. Throughout the school year, the coordinator of science will work with lead teachers, instructional coaches, and principals to monitor the impact of the *Amplify Science* instructional resources. The Phase 4 work will include:

- Assessing student progress using assessments embedded in the program
- Planning and activating the ongoing program evaluation design
- Collecting teacher feedback

Phase 5 of the curriculum review cycle will be conducted from September 2018 through June 2021. Phase 5 work includes monitoring the use of the curriculum with the following processes:

- Analyzing student work on end-of-unit assessments
- Analyzing state assessment results
- Reviewing data to determine the extent to which curriculum alignment is present
- Reviewing and updating curriculum guides and assessments as necessary

- Continuing professional learning and monitoring impact
- Evaluating the improvements made

Recommendation

Administration recommends that the Curriculum/Program Standing Committee forward the recommendation to purchase kindergarten through fifth grade *Amplify Science* curriculum materials to the full Board of Education on March 28, 2017.

Dr. Sue Savaglio-Jarvis
Superintendent of Schools

Mrs. Julie Housaman
Chief Academic Officer

Mrs. Christine Pratt
Coordinator of Science

POLICY 6300
CURRICULUM DEVELOPMENT AND IMPROVEMENT

A prekindergarten through twelfth grade curriculum shall be established and maintained in accordance with state law, the needs of society, the local community, and the individual student.

The District's academic content standards adopted by the School Board shall serve as the basis for all curriculum and instructional program development in the District.

A cyclical curriculum development process for all fields of study will provide a comprehensive evaluation of course content, an inclusive curriculum development process, a thoughtful implementation, revisions based on data, and time for program effectiveness to be realized. The cyclical curriculum development process includes five phases encompassing seven years of work. In Phase 3 the curriculum design team will determine the curriculum resources and professional learning needs that are critical to advance the curriculum development process to Phase 4. A budget assumption will be brought to the school board for approval annually during Phase 3.

Recommendation for additions or deletions to the established curriculum shall be reviewed by the Assistant Superintendent of Teaching and Learning and provided to the Superintendent of Schools and School Board for approval.

LEGAL REF: Wisconsin Statutes
Sections 118.01 (Instructional program goal requirements)
118.30 (Academic standards and assessment requirements)
120.13 (Board power to do all things reasonable for the cause of education)
121.02(1)(k) &(L) (Rules implementing curriculum state standard)
Wisconsin Administrative Code
PI 8.01(2)(k) & (l) Rules implementing curriculum program standards

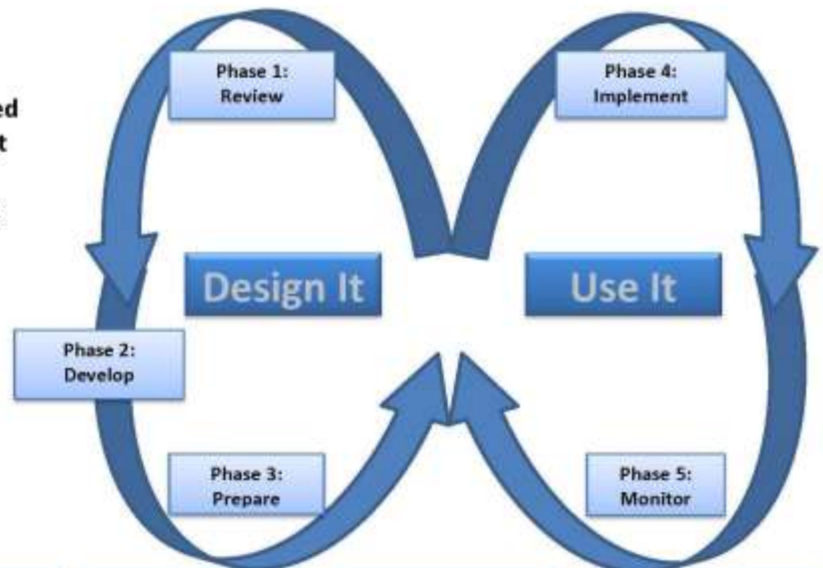
CROSS REF: 6100, Mission, Vision, Core Values and Strategic Directions
6310, Elementary School Curriculum
6610, Selection of Instructional Materials
6620, Library Resources
Board-Adopted Academic Standards
District Learning and Content Standards

AFFIRMED: September 24, 1991

REVISED: November 8, 1994
October 13, 1998
January 29, 2002
December 20, 2011
June 25, 2013
December 15, 2015

RULE 6300
CURRICULUM DEVELOPMENT AND IMPROVEMENT

Kenosha Unified School District Curriculum Development Cycle



Phase 1: Review	Phase 2: Develop	Phase 3: Prepare	Phase 4: Implement	Phase 5: Monitor
• Review Curriculum Audit • Analyze assessments • Study current trends • Affirm philosophy • Deconstruct standards • Create scope and sequence	• Determine units of study • Align written and tested curriculum • Create assessment tools • Complete curriculum guides • Determine resource and professional learning needs	• Gather feedback from focus groups • Recommend and purchase resources pending BOE approval • Plan professional learning	• Deliver professional learning and monitor impact • Assess student progress • Plan and activate program evaluation • Collect feedback	• Analyze student work • Analyze assessment results • Review data • Update curriculum guides • Continue professional learning • Evaluate improvemnts

Kenosha Unified School District

ELEMENTARY SCIENCE INSTRUCTIONAL MATERIALS REVIEW TEAM

LAST NAME	FIRST NAME	SCHOOL/DEPARTMENT
Arnold	Rebecca	Library Media and Instructional Technology
Escobedo**	Mariano	Edward Bain School of Language and Art—Dual Language
Gentz	Barbara	Stocker Elementary School
Gombar	Monica	Strange Elementary School
Hall	Brittany	Grewenow Elementary School
Hughes**	Janet	Nash Elementary School
Hutchins**	Judy	Whittier Elementary School
Jones	Heidi	Grant Elementary School
Keckler	Stacey	Lincoln Middle School
Krone	Carla	Dimensions of Learning Academy
Limbach*	Mary	Brass Community School
Micelli	Amy	Edward Bain School of Language and Art—Dual Language
Miller	Amie	Prairie Lane Elementary School
Roscioli	Jessica	Strange Elementary School
Ruggaber**	Christine	Pleasant Prairie Elementary School
Schmitt**	Kimberly	Nash Elementary School
Walls**	Ruth	Stocker Elementary School
Whyte	Pamela	Lance Middle School
Wood	Diane	Roosevelt Elementary School
Wright	Steven	Indian Trail High School and Academy
Yee*	Sarah	McKinley Elementary School

***Members of the district English/Language Arts Curriculum Team provided start-up guidance only.

**Team leaders

APPENDIX C

VENDOR PRESENTATION AND REVIEW FEEDBACK

Date: January 11, 2017 Vendor:		
Criteria	YES (provide comments)	NO (provide comments)
It was written from the ground up after the NGSS were released and/or is fully aligned with the NGSS. It must show evidence of all three dimensions of the NGSS.		
Hands-on, inquiry based lessons including opportunities for experiences with engineering design are a core part of the curriculum.		
Materials and supply kits are available or easily created to support the lessons.		
Spanish Language student materials are available.		

VENDOR PRESENTATION REVIEW AND FEEDBACK

Date: January 11, 2017 Vendor:		
Criteria	YES (provide comments)	NO (provide comments)
The curriculum supports common core literacy and math skill development		
Teacher and student resources are available in a web-based digital format.		
Bonus: The curriculum contains content and activities for teaching computer science coding.		

Additional Notes:

The Wisconsin Department of Public Instruction and Wisconsin Society for Science Teachers prepared this rubric for educator teams to use to evaluate science education textbooks or other **large-scale** sets of instructional resources. It could also be used to guide adaptation of current sets of resources and determine **professional development** needs. Because the criteria is aligned to the Next Generation Science Standards and the NRC Framework for K-12 Science Education, a **comprehensive understanding** of these documents, including the progressions of learning detailed in them, **must** be in place prior to using this tool. Groups should adapt this tool based on local needs and vision.

The NRC Framework clearly emphasizes the following shifts in science education that should be present in instructional resources:

1) **Three-dimensional learning** – students engage in science and engineering practices to learn content, while relating and understanding that content through the lens of crosscutting concepts.
2) **Explaining phenomena and designing solutions** – students investigate the world around them to explain phenomena and use their scientific understanding to design solutions to problems.
3) **Engineering design and the nature of science** – students do authentic work of scientists and engineers, explicitly seeing themselves in those roles and understanding what that entails.
4) **Coherent learning progressions** – within a grade and from K-12, three-dimensional learning builds on past experience, avoiding redundancy and building connections across disciplines.
5) **Connections to English/language arts and mathematics** – students' learning reflects real-world contexts as it explicitly uses practices and understandings from mathematics and English/language arts.

DPI recommends the following elements of a textbook/instructional resources review process using this tool:

- Teams reviewing texts could include teachers, administrators, community members, Institute of Higher Education (IHE) representatives, and students.
- If they do not have one, schools should establish a vision for students' science education to ensure that instructional resources selected align with this vision.
- Teams should collaboratively review a series of lessons or units, then review another set of lessons, checking for consistent quality throughout instructional resources. Team members should use these lessons/units to provide examples and evidence for analysis in each category (row).
- No material will meet all of these Next Generation criteria, so **it is important to consider the characteristics holistically, not as checklists**. Therefore, before you evaluate, you will need to consider which among these categories are your **non-negotiables**.
- In the end, teams will want to evaluate instructional resources based on where the majority of alignment evidence falls. The final analysis, written on the last page of this document, should include **claims** for how well these instructional resources align with the school's vision and standards, and whether the team wants to consider them for adoption. The team should provide **evidence** and **reasoning** in relation to that consideration, continually **relating it back to the district's K-12 vision for science education.**
    - A sample statement within the final analysis might be: "To engage students and empower them to make science-based decisions in their life after formal schooling, they need to investigate and make sense of real-world phenomena at a deep level. In these instructional resources, students do that in the investigations noted on pages 30, 72, 112, and 152 of the reviewed resource. This type of work appears to be a consistent element of these instructional resources."
    - Crafting statements like the above sample in relation to all relevant portions of your vision for science education will support decision-making about instructional resources adoption.

This evaluation tool draws heavily from the EQuIP rubric and PEEC alignment tools, developed by Achieve.

Title of Instructional Resources Reviewed:

Characteristic	Less Like…	More Like…	Questions, Examples/Evidence, & Comments
A) Approach to Phenomena	● Organized by big content ideas, each section/chapter has lab idea(s) that largely confirm learning about that content. ● Student work confirms theories and equations and/or generally follows a set procedure. ● Student learning is centered on facts; content is an end in itself. ● Learning has limited explicit connection to students' day-to-day lives and questions. ● Learning may be difficult, but is not conceptually rigorous.	● Learning is organized around essential questions and investigating meaningful phenomena within a storyline. ● Students have opportunities to design investigations and build evidence for scientific models that explain phenomena. ● The primary goals are making sense of the world and solving problems, **not** *covering* content. ● Students have opportunities to initiate explorations linked to what they think is important, what they wonder about, and what is happening in their local context.	
B) Three Dimensional	● Instructional resources emphasize the use of ***a*** scientific method. ● Students make predictions but have little grounding for them or the outcomes are obvious.	● Students engage in multiple **scientific and engineering practices** (no longer "*a* scientific method") to learn about the world around them and solve problems. ● Learning is framed by **crosscutting concepts** (cross-disciplinary science ideas). ● A blend in practices, **disciplinary core ideas**, and crosscutting concepts is evident in how material is presented, not just what students are asked to do.	
C) Crosscutting Concepts	● Concepts are not intentionally connected from unit to unit; they tend to be presented in silos. ● Big ideas of science are treated as a separate chapter or lesson.	● As an integral part of their work, students make sense of and ask questions of phenomena across disciplines using the lens of crosscutting concepts. ● Crosscutting concepts frame scientific inquiry and illustrate connections across scientific disciplines, with consistent,	

		explicit use of that language (i.e., cause and effect, scale, systems, etc.).	
D) Clear Learning Objectives Linked to Essential Questions	• Each lesson has objectives for student learning. The objectives are typically about learning particular content. • Content-based questions begin and/or end each lesson, unit, and/or chapter.	• Multiple lessons work together towards objectives/enduring understandings that include practices, core ideas, and crosscutting concepts. Performance expectations inform objectives. • Lessons include essential and additional questions that prompt sense-making of phenomena and means for doing so. • Students understand how objectives and questions connect to big ideas of the unit.	
E) Clear Progression Across and Within Grades with Focused Content	• Content and use of the scientific method gets progressively more advanced from grade to grade. • Instructional resources provide details on a broad range of content at each grade level. • Information is scientifically accurate.	• There is a clear progression of disciplinary core ideas, practices, and crosscutting concepts within a grade and from grade to grade. • Instructional resources focus on narrow, coherent, and developmentally appropriate sets of content at each grade level, supporting a vertical progression of conceptual understanding. • Information is scientifically accurate.	
F) Teacher Supports	• Instructional resources include guidance on how to teach the lessons and use the resources as a whole. • Specifies instructional resources to be used and provides instructional resources when kit-based. • Potential safety concerns are listed. • Demonstration ideas are provided.	• Embedded professional development provides tailored supports at ES, MS, and HS, such as additional content background information, learning progressions, coherent storylines, and guidance on conducting three-dimensional investigations. • Supports research-based instructional practice. • Student preconceptions are identified with guidance for how to work with them.	

		● Specifies materials to be used; provides quality, durable equipment if kit-based. Potential safety concerns are listed and explained.	
G) Dialogue and Communication, Links to CCSS ELA	● Instructional resources provide for group work and written lab reports. ● Whole-class and individual questions are provided. ● Students respond to formative and summative questions that are largely content-based. ● Text presents vocabulary to learn.	● Supports for structured whole-class and small group communication and dialogue are part of every lesson and investigation. ● Notebooking supports are provided. ● Investigations ask students to formally and informally present and defend their claims with evidence, attending to audience and using proper vocabulary. ● Argumentation is an expectation.	
H) Links to CCSS Math	● Students use formulas and make calculations. ● Students graph their data and make sense of various displays of data.	● Students create and evaluate mathematical models in their explanations and understanding of scientific phenomena. ● Instructional resources focus on a conceptual understanding of simulations and models, allowing for students to manipulate, evaluate, and create such models through computational thinking. ● Students create, interpret, use, and evaluate graphical displays of data, ensuring accurate explanations.	
I) Engineering	● Instructional resources provide some examples of engineering as applications of science knowledge.	● Students engage in engineering design (defining problems with criteria and constraints, designing and testing solutions, etc.) to solve meaningful problems. ● Engineering work extends and deepens student understanding of science content and practice, and students see how	

		science and engineering function together.	
J) Nature of Science and Diversity of Perspective	• Students only learn about the nature of science (how science is practiced and discussed) in one chapter. • Students learn about the work of significant scientists from history.	• The nature of science is embedded throughout student learning from a current and historical context. • Instructional resources connect students to the content and practice of actual scientists and engineers, including current and past work by a diverse group of scientists and engineers. Students see people like themselves. • Students are given real-world opportunities to work like scientists and engineers, emphasizing that STEM fields require perseverance and a growth mindset.	
K) Differentiation: Meet Needs of All Learners	• Instructional resources provide some ideas to differentiate learning processes, required products, and/or content; examples might include an easier version of an assessment or less complicated project options. • Writing is the primary response mode. • Resources are provided in Spanish or other languages as needed. • Concepts learned and lab activities are largely presented in one way with one pathway through them.	• Instructional resources include specific strategies for engaging and supporting *all* students. • Students consistently have multiple pathways/modalities for showing their understanding of concepts, and have choices in learning that allow them to connect to meaningful aspects of their culture and community. • Instructional resources emphasize high standards for learning and the products that represent learning. • Connecting to and supporting diverse interests and learning needs are infused throughout, including other languages and reading levels.	
L) Formative Assessment	• Instructional resources provide student questions related to each	• Provide structured supports for ongoing assessments linking to practices, core	

	lesson and quizzes across multiple lessons. Assessments largely focus on understanding the content, but may connect to some areas of practice such as interpreting graphs. ● Assessments are related to learning objectives.	ideas, and crosscutting concepts, with guidance for using the data to determine next steps. ● Provide specific strategies for how to support students struggling with concepts and skills. ● Comes in several formats, related to learning objectives and progressions, with examples of how students might demonstrate proficiency in multiple modes.	
M) Summative Assessment	● Summative tests include lengthy lists of content-based questions, with some open-ended explanation and reasoning required. ● Typically provided at the end of each chapter or unit.	● Emphasizes authentic assessments such as portfolios, projects, performance tasks, and hands-on work, where the line between assessment and typical learning activities is blurred. ● Allows for student work across the three dimensions, not just working with each separately. ● Includes differentiated assessment options with multiple means for expressing understanding. ● Provides quality rubrics that emphasize a true progression of learning, not relying on such categories as sometimes, never, or always to differentiate levels of learning.	
N) Technology and Instructional Resources Connections	● Includes links to related websites. ● Ideas for integrating technology are provided.	● Instructional resources guide students' use of technological tools for research, data collection and analysis, modeling, collaboration, communication, etc. ● Technology tools and connections support depth of learning and other benefits that could not be accomplished otherwise.	

		● Students have opportunities to determine when and how to best use technology tools.	
O) Other Characteristics Determined Locally			

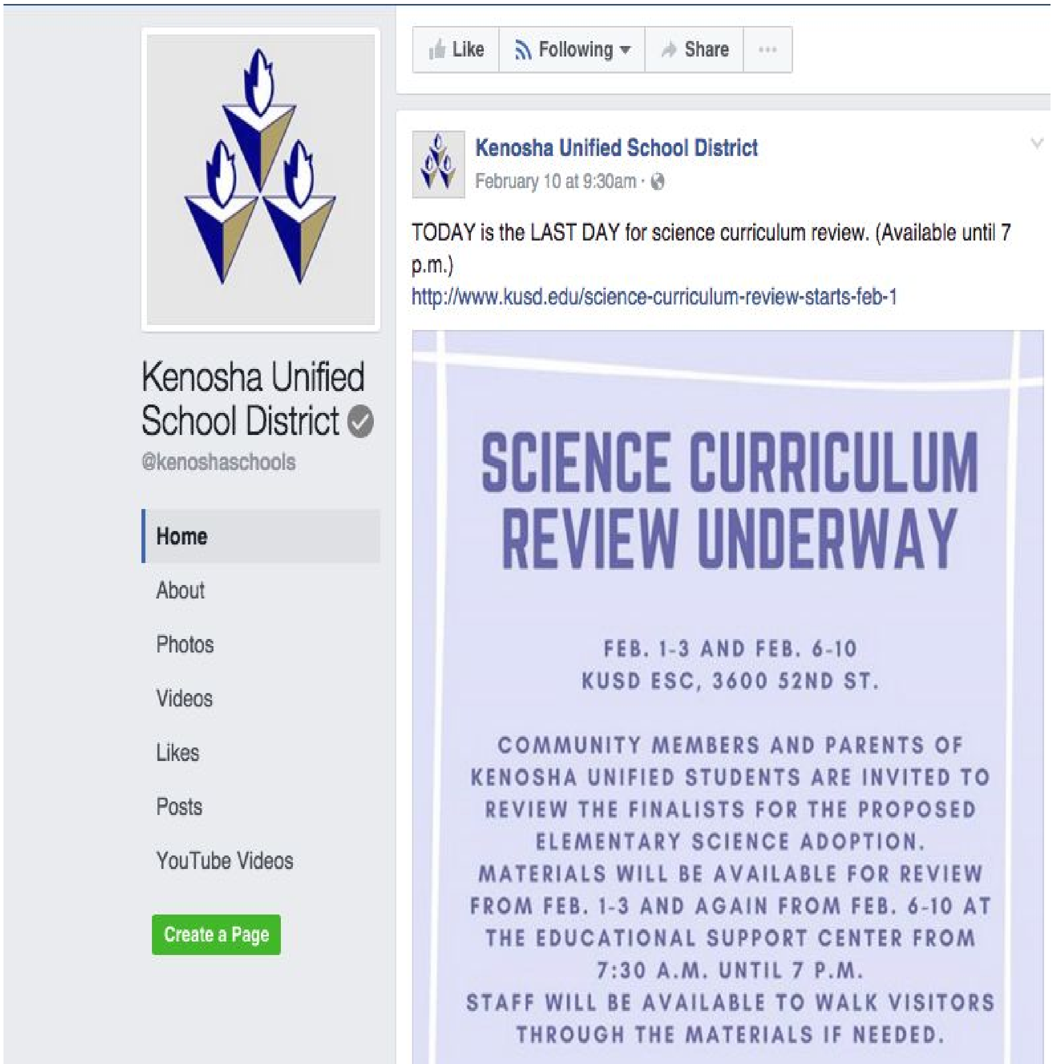
Final Analysis

It is critical for districts to conduct this evaluation thoroughly and thoughtfully. A superficial review of texts and instructional resources will likely have long-reaching consequences for teachers and students. Notably, all characteristics may not be equally weighted in your analysis. Teams of educators will have to determine which characteristics and evidence are most important based on their context and needs.

- **Recommendation(s) for these resources:**
  Examples: pilot, adopt, adopt at grade(s) ___, do not adopt, use but not as core material for unit, return to publisher, etc.

- **Our evidence-based reasoning for how this resource aligns with our school's/district's vision for science education includes**:
  Example: "To engage students and empower them to make science-based decisions in their life after formal schooling, they need to investigate and make sense of real-world phenomena at a deep level. In these instructional resources, students do that in the investigations noted on pages 30, 72, 112, and 152 of the reviewed resource. This type of student engagement appears to be a consistent element of these instructional resources."

- **Additional comments/questions:**



Media posts were made on the following dates:

2:30 p.m. Thursday, Feb. 2 – Twitter
2:30 p.m. Thursday, Feb. 2 – Facebook
7:30 a.m. Friday, Feb. 3 – Facebook
12 p.m. Saturday, Feb. 4 – Facebook
6:45 p.m. Sunday, Feb. 5 – Facebook
10 a.m. Monday, Feb. 6 – Facebook
2:45 p.m. Tuesday, Feb. 7 – Facebook
5 p.m. Wednesday, Feb. 8 – Facebook
8:30 a.m. Thursday, Feb. 9 – Facebook
9:30 a.m. Friday, Feb. 10 – Facebook
10:30 a.m. Friday, Feb. 10 – Twitter

Kenosha Unified School District

ELEMENTARY SCIENCE
CURRICULUM REVIEWERS

LAST NAME	FIRST NAME	SCHOOL	ROLE
Allen	Theresa	Forest Park Elementary School	Fifth grade teacher
Bakula	Jen	Nash Elementary School	Parent
Bell-Myers	Andrea	Brass Elementary School	Fifth grade teacher
Cascio	Jody	Forest Park Elementary School	Principal
Contreras-Howe	Aurora	Bradford High School	Parent
Fennama-Jansen	Sally	Special Education and Student Support	Assistive technology teacher consultant
Hutchins	Judy	Whittier Elementary School	Kindergarten teacher
Jagel	Maggie	Whittier Elementary School	Kindergarten teacher
Knudtson	Diane	Whittier Elementary School	Fifth grade teacher
LaLonde	Wendy	Somers Elementary School	Principal
Lowen	Suzanne	The Brompton School	Principal
Medina	Brunilda	Edward Bain School of Language and Art—Dual Language	Third grade teacher
Padjen	Naomi	Whittier Elementary School	Special education teacher for visually impaired students
Torres	Maggie	Roosevelt Elementary School	English-as-a-second-language teacher
Valeri	Susan	Special Education and Student Support	Chief of special education and student support
Wood	Diane	Roosevelt Elementary School	International Baccalaureate® coach
Anonymous	--	Southport Elementary School	English-as-a-second-language teacher
Anonymous	--	Kenosha, Wisconsin	Community member
Group Feedback		Special Education and Student Support	Program support teachers

AMPLIFY SCIENCE
SAMPLE RESPONSES FROM COMMUNITY REVIEW OPPORTUNITIES

STRENGTHS	QUESTIONS AND CONCERNS
It is tied to the standards.	It is a brand new curriculum.
It is a hands-on curriculum.	Will there be braille access?
It is visually appropriate for elementary students.	There are no word boxes on the writing pages.
The materials are teacher friendly.	This is a new way of engaging students in learning so training and support will be critical.
The engineering notes are age appropriate.	Will the on-line simulations be available for students to use at home?
Student inquiry and metacognition are evident throughout the curriculum.	The materials and concepts may be difficult for teachers without a science background.
It has a science, technology, engineering, and mathematics focus with step-by-step instructions.	There are not enough pictures to help engage students.
Focusing on understanding all of the science concepts within one project helps students.	Strong training will be needed.
It is inquiry based.	The strategies for supporting English language learners and the differentiated instruction strategies were hard to find.
It requires thinking and defending reasoning and has a real-world approach to solving problems.	On some days technology does not cooperate, so we might need to have a back-up plan for accessing the web-based materials.
There are simulations for students to help understanding.	
Strong writing and speaking components encourage cross-curricular opportunities.	
The investigations are great and will provide opportunities for enrichment.	
The unit at a glance is very helpful.	
Hands-on and partner work provide multiple ways of learning.	
It has layers of creativity and creates an authentic experience.	
It incorporates the arts.	
The student materials have good thought-provoking questions.	
It allows instruction to occur in authentic, expeditionary, and culturally relevant ways.	

Kenosha Unified School District

3600 52ND ST., KENOSHA, WI 53144
P 262-359-6300 • F 262-359-7672

PURCHASE/CONTRACT RATIONALE

Per School Board Policy 3420, please complete the following to be attached to your purchase order/contract. Additional information may be required and presented before the District's School Board for approval. Your submission must allow for adequate time for the Board to approve.

Vendor: Amplify.

Purchased Good/Program: Amplify Science Curriculum Kindergarten – Fifth Grade

Start Date/Date Needed: May 1, 2017

1. PURPOSE – What is the purpose of the proposed purchase?

   The purchase of these materials will provide kindergarten through fifth grade science instructional materials aligned to the district's science standards.

2. FUNDING – What is the total cost of purchase and the funding source?

   The quote for materials and services is $899,047 and the funding source is the Teaching and Learning budget. The purchase includes: teacher materials, license for digital courseware, training for instructional staff.

3. REQUEST FOR PROPOSAL (RFP) – indicate if an RFP has been completed

   YES X NO ☐ If no, please request an RFP packet

4. EDUCATIONAL OUTCOME – What is the educational outcome of this purchase?

   - Support the content teaching standards outlined in the district science curriculum.
   - Provide resources to support all learner's needs (e.g., students learning a second language, special education students, students needing scaffolded support above or below grade level, etc.).

5. START DATE – When is the anticipated start date?

August 29, 2017

Your response does not establish approval of either a contract or a purchase order.
Appropriate Leadership Signature Julie Hamann Date 2-21-17

Amplify Science Materials for Kindergarten - Fifth Grade

GRADE	DESCRIPTION	QUANTITY	COST	TOTAL
	Teacher Instructional Guides Annual License/Digital Teacher Guide			
K	Amplify Science Elementary School: Kindergarten Physical Science Unit - Pushes and Pulls ONE YEAR License	90	$22.50	$ 2,025.00
K	Amplify Science Elementary School: Kindergarten Life Science Unit - Needs of Plants and Animals ONE YEAR License	90	$22.50	$ 2,025.00
K	Amplify Science Elementary School: Kindergarten Earth Science Unit - Sunlight and Weather ONE YEAR License	90	$22.50	$ 2,025.00
1	Amplify Science Elementary School: First Grade Physical Science Unit - Light and Sound ONE YEAR License	90	$22.50	$ 2,025.00
1	Amplify Science Elementary School: First Grade Life Science Unit - Plant and Animal Defenses ONE YEAR License	90	$22.50	$ 2,025.00
1	Amplify Science Elementary School: First Grade Earth Science Unit - Spinning Earth ONE YEAR License	90	$22.50	$ 2,025.00
2	Amplify Science Elementary School: Second Grade Physical Science Unit - Properties of Materials ONE YEAR License	90	$22.50	$ 2,025.00
2	Amplify Science Elementary School: Second Grade Earth Science Unit - Changing Landforms ONE YEAR License	90	$22.50	$ 2,025.00
2	Amplify Science Elementary School: Second Grade Life Science Unit - Plant and Animal Relationships ONE YEAR License	90	$22.50	$ 2,025.00
3	Amplify Science Elementary School: Third Grade Physical Science Unit - Balancing Forces ONE YEAR License	90	$22.50	$ 2,025.00
3	Amplify Science Elementary School: Third Grade Life Science Unit A - Inheritance and Traits ONE YEAR License	90	$22.50	$ 2,025.00
3	Amplify Science Elementary School: Third Grade Life Science Unit B - Environments and Survival ONE YEAR License	90	$22.50	$ 2,025.00
3	Amplify Science Elementary School: Third Grade Earth Science Unit - Weather and Climate ONE YEAR License	90	$22.50	$ 2,025.00
4	Amplify Science Elementary School: Fourth Grade Physical Science Unit A - Energy Conversions ONE YEAR License	90	$22.50	$ 2,025.00
4	Amplify Science Elementary School: Fourth Grade Physical Science Unit B - Waves, Energy, and Information ONE YEAR License	90	$22.50	$ 2,025.00
4	Amplify Science Elementary School: Fourth Grade Life Science Unit - Vision and Light ONE YEAR License	90	$22.50	$ 2,025.00
4	Amplify Science Elementary School: Fourth Grade Earth Science Unit - Earth's Features ONE YEAR License	90	$22.50	$ 2,025.00
5	Amplify Science Elementary School: Fifth Grade Physical Science Unit - Modeling Matter ONE YEAR License	90	$22.50	$ 2,025.00
5	Amplify Science Elementary School: Fifth Grade Life Science Unit - Ecosystem Restoration ONE YEAR License	90	$22.50	$ 2,025.00
5	Amplify Science Elementary School: Fifth Grade Earth Science Unit A - Patterns of Earth and Sky ONE YEAR License	90	$22.50	$ 2,025.00
5	Amplify Science Elementary School: Fifth Grade Earth Science Unit B - The Earth System ONE YEAR License	90	$22.50	$ 2,025.00
		SUB-TOTAL teacher materials		$ 42,525.00
	Lesson Equipment Kits Support 36 Students X 2 uses. Kits include student texts: 5 books X 18 of each book.			
K	Amplify Science Elementary School: Kindergarten Physical Science Unit - Pushes and Pulls Kit	45	$1,275.00	$ 57,375.00
K	Amplify Science Elementary School: Kindergarten Life Science Unit - Needs of Plants and Animals Kit	45	$1,095.00	$ 49,275.00
K	Amplify Science Elementary School: Kindergarten Earth Science Unit - Sunlight and Weather Kit	45	$1,095.00	$ 49,275.00
1	Amplify Science Elementary School: First Grade Physical Science Unit - Light and Sound Kit	45	$1,615.00	$ 72,675.00
1	Amplify Science Elementary School: First Grade Life Science Unit - Plant and Animal Defenses Kit	45	$1,095.00	$ 49,275.00
1	Amplify Science Elementary School: First Grade Earth Science Unit - Spinning Earth Kit	45	$1,095.00	$ 49,275.00
2	Amplify Science Elementary School: Second Grade Physical Science Unit - Properties of Materials Kit	45	$1,300.00	$ 58,500.00
2	Amplify Science Elementary School: Second Grade Earth Science Unit - Changing Landforms Kit	45	$1,095.00	$ 49,275.00
2	Amplify Science Elementary School: Second Grade Life Science Unit - Plant and Animal Relationships Kit	45	$1,095.00	$ 49,275.00
3	Amplify Science Elementary School: Third Grade Physical Science Unit - Balancing Forces Kit	25	$1,015.00	$ 25,375.00
3	Amplify Science Elementary School: Third Grade Life Science Unit A - Inheritance and Traits Kit	25	$1,095.00	$ 27,375.00
3	Amplify Science Elementary School: Third Grade Life Science Unit B - Environments and Survival Kit	25	$1,095.00	$ 27,375.00
3	Amplify Science Elementary School: Third Grade Earth Science Unit - Weather and Climate Kit	25	$1,095.00	$ 27,375.00
4	Amplify Science Elementary School: Fourth Grade Physical Science Unit A - Energy Conversions Kit	25	$1,070.00	$ 26,750.00
4	Amplify Science Elementary School: Fourth Grade Physical Science Unit B - Waves, Energy, and Information Kit	25	$1,050.00	$ 26,250.00
4	Amplify Science Elementary School: Fourth Grade Life Science Unit - Vision and Light Kit	25	$1,095.00	$ 27,375.00
4	Amplify Science Elementary School: Fourth Grade Earth Science Unit - Earth's Features Kit	25	$1,095.00	$ 27,375.00
5	Amplify Science Elementary School: Fifth Grade Physical Science Unit - Modeling Matter Kit	25	$1,205.00	$ 30,125.00
5	Amplify Science Elementary School: Fifth Grade Life Science Unit - Ecosystem Restoration Kit	25	$1,175.00	$ 29,375.00
5	Amplify Science Elementary School: Fifth Grade Earth Science Unit A - Patterns of Earth and Sky Kit	25	$1,095.00	$ 27,375.00
5	Amplify Science Elementary School: Fifth Grade Earth Science Unit B - The Earth System Kit	25	$1,095.00	$ 27,375.00
		SUB-TOTAL student materials		$ 813,700.00
	Shipping/Handling 50% discount provided of $(42,822)	1		**$ 42,822.00**
	TOTAL			**$ 899,047.00**

Amplify Science Elementary School Unit Summaries

Physical Science

Name and Summary	NGSS Performance Expectations Addressed
Pushes and Pulls: Designing a Pinball Machine Students play the role of pinball machine engineers as they explore the effects of pushes and pulls on the motion of an object. They conduct tests in their own prototypes (models) of a pinball machine contributing to the design of a class pinball machine.	K-PS2-1: Pushes and Pulls K-PS2-2: Change Speed and Direction K-2-ETS1-1: Defining the Problem K-2-ETS1-2: Developing Possible Solutions K-2-ETS1-3: Comparing Different Solutions
Light and Sound: Puppet Theater Engineers In their role as light and sound engineers, students investigate cause and effect relationships to learn about the nature of light and sound. They apply what they learn to design shadow scenery and sound effects for a puppet show.	1-PS4-1: Sound and Vibration 1-PS4-2: Seeing Requires Light 1-PS4-3: Light Interaction with Materials 1-PS4-4: Light and Sound for Communication K-2-ETS1-1: Defining the Problem K-2-ETS1-2: Developing Possible Solutions K-2-ETS1-3: Comparing Different Solutions
Properties of Materials: Designing Glue As glue engineers, students use engineering design practices to create a glue for use at their school. They conduct tests that yield quantifiable results, graph their data, analyze and interpret results, and then use that evidence to iteratively design a series of glue mixtures, each one better than the one before.	2-PS1-1: Properties of Materials 2-PS1-2: Materials for Specific Purposes 2-PS1-3: Pieces Can be Made Into New Objects 2-PS1-4: Changes Caused by Heating and Cooling K-2-ETS1-1: Defining Problems K-2-ETS1-3: Developing Possible Solutions
Balancing Forces: Investigating Floating Trains In their role as consulting scientists, students are challenged to figure out how a floating train works in order to explain it to the citizens of the fictional city of Faraday. They apply ideas about non-touching forces as well as balanced and unbalanced forces.	3-PS2-1: Balanced and Unbalanced Forces 3-PS2-2: Predicting Motion 3-PS2-3: Non-Touching Forces 3-PS2-4: Solve Problem with Magnets

Energy Conversions: **Blackout in Ergstown** Students play the role of systems engineers for Ergstown, a fictional town that experiences frequent blackouts. They explore reasons why an electrical system can fail, choose new energy sources and energy converters for the town, and use evidence to explain why their choices will make the town's electrical system more reliable.	4-PS3-1: Relationship Between Speed and Energy 4-PS3-2: Energy can be Transferred 4-PS3-3: Collisions 4-PS3-4: Design an Energy Converter 4-ESS3-1: Energy and Fuels 3-5-ETS1-1: Defining the Problem 3-5-ETS1-2: Developing Possible Solutions
Waves, Energy, and Information: **Investigating How Dolphins Communicate** In their role as marine scientists, students work to figure out how mother dolphins communicate with their calves. They investigate how sound travels and learn about how to look for and to create patterns of communication.	4-PS3-2 Energy Can Be Transferred 4-PS3-3: Collisions 4-PS4-1: Waves 4-PS4-3: Patterns to Transfer Information 4-LS1-2: Info, Senses and the Brain 4ESS3-2: Reduce Impacts of Earth Processes 3-5-ETS1-1: Defining the Problem 3-5-ETS1-2: Developing Possible Solutions
Modeling Matter: The Chemistry of Food As food scientists working in a lab for a large food production company, students take on two work assignments, one related to food safety and one related to creation of a new food product. In so doing, they figure out that the properties of materials are related to the properties of the nano-particles that make up those materials.	5-PS1-1: Matter is made of Particles 5-PS1-3: Properties of Materials 5-PS1-4: Mixing Substances

Earth and Space Science

Name and Summary	NGSS Performance Expectations Addressed
Grade K **Sunlight and Weather:** **Solving Playground Problems** In their role as weather scientists, students look into why one fictional schoolyard is too cold in the morning, while another, which is nearby, is too hot in the afternoon. They use physical models and firsthand investigation to figure out the impact of sunlight on Earth's surface.	K-PS3-1: Sunlight on Earth's Surface K-PS3-2: Reducing Warming K-ESS2-1: Weather Patterns K-ESS3-2: Preparing for Severe Weather K-2-ETS1-1: Defining the Problem K-2-ETS1-2: Developing Possible Solutions K-2-ETS1-3: Comparing Different Solutions
Grade 1 **Spinning Earth:** **Investigating Patterns in the Sky** As emerging space scientists, students figure out how to explain why it is never the same time of day for a grandmother who lives in Asia, as it is for her grandson in the United States when she calls him. Students record, organize and analyze observations of the Sun and other sky objects as they look for patterns and make sense of the cycle of daytime and nighttime.	1-ESS1-1: Observable Patterns of Sky Objects 1-ESS1-2: Amount of Daylight
Grade 2 **Changing Landforms:** **The Disappearing Cliff** Students play the role of Earth scientists, as they attempt to figure out what caused a rock cliff to change shape over time. They use models to investigate the erosion of rock and the formation of sand.	2-ESS1-1: Fast and Slow Earth Events 2-ESS2-1: Slowing the Erosion of Land Forms 2-ESS2-2: Landforms and Bodies of Water 2-ESS2-3: Water on Earth

Grade 3 **Weather and Climate:** **Establishing an Orangutan Colony** As weather scientists for a nature conservation group, students determine which of four fictional islands will be the best location for an orangutan reserve. They analyze and interpret weather data in order to compare and construct arguments about the weather patterns for a particular location in the world over a given span of time.	3-ESS2-1: Represent Weather Patterns 3-ESS2-2: Describe Climates 3-ESS3-1: Reducing Impact of Weather Hazards 3-5-ETS1-2: Developing Possible Solutions
Grade 4 **Earth's Features:** **Mystery in Desert Rocks Canyon** Playing the role of geologists, students help the National Park Service to explain what a particular boney-looking rock is, how it formed, and how it came to be in its current location at the bottom of Desert Rocks National Park. Then they explain how the canyon where they are doing their research formed to park visitors.	4-ESS1-1: Landscape Changes 4-ESS2-1: Evidence of Weathering or Erosion 4-ESS2-2: Patterns of Earth's Features 4-ESS3-1: Energy and Fuels 4-ESS3-2: Reduce Impacts of Earth Processes
Grade 5 **Patterns of Earth and Sky:** **Analyzing Stars on Ancient Artifacts** In their role as astronomers, students investigate an artifact found on an archeological dig that seems to show patterns in the daytime and nighttime sky. Using a computer simulation of stars, physical models, and a reference text, students figure out how the position of stars around the Earth, and the spin and orbit of the Earth cause us to see daily and yearly patterns of stars.	5-PS2-1: Gravity 5-ESS1-1: Apparent Brightness of Stars 5-ESS1-2: Patterns of Daily and Seasonal Changes

Grade 5 **The Earth System: Investigating Water Shortages** As water resource engineers, students figure out what caused a water shortage on the east side of a fictional island, East Ferris, and work to design a solution to the problem. Applying their knowledge of water distribution and analyzing the flow of water between the hydrosphere, atmosphere, and geosphere, students communicate the nature of the problem and possible solutions to the people of East Ferris.	5-ESS2-1: Interaction of Spheres 5-ESS2-2: Distribution of Water on Earth 5-ESS3-1: Protecting Earth 5-PS1-1: Matter is Made of Particles 5-PS1-2: Conservation of Matter 5-PS1-3: Properties of Materials 5-PS1-4: Mixing Substances 3-5-ETS1-1: Defining Problems 3-5-ETS1-2: Developing Possible Solutions 3-5-ETS1-3: Improving Solutions

Life Science

Name and Summary	NGSS Performance Expectations Addressed
Grade K **Needs of Plants and Animals: Milkweed and Monarchs** Students take on the role of scientists in order to figure out why there are no monarch caterpillars in the Garden since the vegetables were planted. In so doing, they investigate how plants and animals get what they need to live and grow, and make a new plan for the community garden that provides for the needs of the monarch caterpillars in addition to vegetables for humans.	K-LS1-1: Survival Needs K-ESS2-2: Impacting Environment K-ESS3-1: Qualities of a Habitat K-ESS3-3: Reducing Impacts K-2-ETS1-1: Defining the Problem K-2-ETS1-2: Developing Possible Solutions
Grade 1 **Animal and Plant Defenses: Spikes, Shells, and Camouflage** Students play the role of marine scientists. In their role, students apply their understanding about plant and animal defense structures to explain to concerned visitors to an aquarium how a sea turtle at	1-LS1-1: Mimicking Organisms' Structures 1-LS1-2: Parents Promote Survival of Offspring 1-LS3-1: Young Organisms Resemble Parents

the aquarium, can be released and will be able to defend herself and her offspring from predators in the ocean.	
Grade 2 **Plant and Animal Relationships: Investigating Systems in a Bengali Forest** In their role as plant scientists working at the Bengal Tiger Reserve, students work to figure out why there are no new Chalta trees growing in this part of the forest. Students investigate what the Chalta tree needs to survive, and collect and analyze qualitative and quantitative data to solve the mystery.	2-LS2-1: Sunlight and Water for Plants 2-LS2-2: Animals' Role in Seed Dispersal 2-LS4-1: Diversity of Life in Different Habitats K-2-ETS1-1: Defining the Problem K-2-ETS1-2: Developing Possible Solutions K-2-ETS1-3: Comparing Different Solutions
Grade 3 **Inheritance and Traits: Variation in Wolves** Students play the role of wildlife biologists working in Greystone National Park, as they study two wolf packs and are challenged to figure out why an adoptive wolf in one of the packs, has the traits it does. Students investigate variation between and within different species, inherited and acquired traits, and conclude the unit by writing an explanation of the origin of the adoptive wolf's traits for the visitors in Greystone National Park.	3-LS1-1: Life Cycles and Life Stages 3-LS2-1: Animals' Social Interactions 3-LS3-1: Traits are Inherited and Vary 3-LS3-2: Traits can be Influenced by Environment
Grade 3 **Environments and Survival: Snail Trait Biomimicry** As engineers that specialize in biomimicry, designing structures that are modeled on organisms in the natural world, students investigate the adaptive traits of the Grove Snail population, and use what they learn to design a protective shell to transport endangered sea turtle eggs.	3-LS2-1: Animals' Social Interactions 3-LS4-1: Fossils and Evidence of Environment 3-LS4-2: Adaptive and Non-Adaptive Traits 3-LS4-3: Survival Impact of Different Environments 3-LS4-4: Solutions to Environmental Changes 3-5-ETS1-1: Defining the Problem 3-5-ETS1-2: Developing Possible Solutions 3-5-ETS1-3: Improving Designs

Grade 4 **Vision and Light: Investigating Animal Eyes** As wildlife biologists, students work to figure out why a local population of geckos has decreased since the construction of a new stadium. Students consider the bright lights of the stadium and use a computer simulation to investigate the relationship of light and vision, specifically the sensitivity of different animals' eyes to light and make a recommendation for mitigating the situation.	4-PS4-2: Light is Necessary for Sight 4-LS1-1: Internal and External Structures 4-LS1-2: Patterns to Transfer Information 4-PS4-3: Information, Senses and the Brain 3-5-ETS1-1: Defining the Problem 3-5-ETS1-2: Developing Possible Solutions 3-5-ETS1-3: Improving Designs
Grade 5 **Ecosystem Restoration: Matter and Energy in a Rainforest** Students engage as ecologists as they figure out why the plants and animals in a failing Costa Rican rainforest ecosystem aren't growing and thriving. Growing a terrarium, using physical models, and investigating how matter and energy flow with a computer model, students solve the mystery and create a plan for rainforest restoration.	5-PS3-1: Use and Origin of Energy in Food 5-LS1-1: Plant Materials from Air and Water 5-LS2-1: Matter Flows 5-ESS3-1: Protecting Earth 5-PS1-1: Matter is Made of Particles 3-5-ETS1-1: Defining the Problem 3-5-ETS1-2: Developing Possible Solutions

Grade K: *Pushes and Pulls: Designing a Pinball Machine*

Unit at a Glance

Chapter 1: How do we make a pinball start to move?

1.1 Pre-Unit Assessment: Students' Initial Explanations	1.2 Talking About Forces	1.3 Forces Happen Between Two Objects	1.4 We Are Engineers	1.5 Writing About Forces

Chapter 2: How do we make a pinball move as far as we want?

2.1 Exploring Shorter and Longer Distances	2.2 Strong and Gentle Forces	2.3 Designing a New Launcher

Chapter 3: How do we make a pinball move to a certain place?

3.1 Movement in Different Directions	3.2 Building with Forces	3.3 Direction and Strength	3.4 Targets in the Box Model	3.5 Applying Strength and Direction

Chapter 4: How do we make a moving pinball change direction?

4.1 Changing Directions	4.2 Forces Change an Object's Direction	4.3 Flippers and Bumpers

Chapter 5: How can we make the pinball machine do all the things we want it to do?

5.1 Room 4 Solves a Problem	5.2 Testing and Improving Our Box Models	5.3 Showcasing Our Box Models

Chapter 6: Where are forces around us?

6.1 Searching for Forces	6.2 A Busy Day in Pushville	6.3 End-of-Unit Assessment: Students' Culminating Explanations

Unit Question

Why do things move in different ways? (1.1)

Chapter Questions

Chapter 1: How do we make a pinball start to move? (1.1)

Chapter 2: How do we make a pinball move as far as we want? (2.1)

Chapter 3: How do we make a pinball move to a certain place? (3.1)

Chapter 4: How do we make a moving pinball change direction? (4.1)

Chapter 5: How can we make the pinball machine do all the things we want it to do? (5.1)

Chapter 6: Where are forces around us? (6.1)

Investigation Questions

Chapter 1

- What makes an object start to move? (1.1, 1.2, 1.3)

Chapter 2

- What makes an object move shorter or longer distances? (2.1, 2.2, 2.3)

Chapter 3

- What makes an object start moving in a certain direction? (3.1, 3.2)
- What makes an object move to a certain place? (3.3, 3.4, 3.5)

Chapter 4

- What can make a moving object change direction? (4.1, 4.2)

Chapter 5

- How do engineers make their solutions do all the things they want them to do? (5.1)

Chapter 6

- Where are forces in the world? (6.1)

Key Concepts

Chapter 1

- An object starts to move when another object exerts a force on it. (1.3)
- Forces happen between two objects. (1.3)

Chapter 2

- An object moves a long distance when a strong force is exerted on it. (2.2)
- An object moves a short distance when a gentle force is exerted on it. (2.2)

Chapter 3

- An object starts to move in the same direction as the force that starts the motion. (3.2)
- Every force has a strength—gentle or strong—and a direction. (3.3)
- Every force has a strength—gentle or strong—and a direction, which makes the object move a certain distance and direction. (3.4) (Revised from 3.3)

Chapter 4

- A moving object changes direction when another moving object exerts a force on it. (4.2)
- A moving object changes direction when a still object in its way exerts a force on it. (4.2)

Chapter 6

- Whenever we see an object start to move, stop moving, or change direction, that is evidence that something exerted a force on it. (6.1)

Grade K: *Pushes and Pulls: Designing a Pinball Machine*

Overview of Standards and Goals

The *Pushes and Pulls: Designing a Pinball Machine* unit will help students master disciplinary core ideas in physical science while supporting students' development of key science practices such as planning and carrying out investigations, analyzing and interpreting data, designing solutions to problems, and making explanations. The unit incorporates an explicit focus on the crosscutting concept of Cause and Effect, with opportunities to address the crosscutting concept of Structure and Function. The unit provides substantial experience with Common Core State Standards (CCSS) for English Language Arts (ELA) as they relate to reading and writing informational text. The unit includes opportunities to address some CCSS for Mathematics, with optional extensions that allow further standards coverage. The remainder of this document explains how the unit addresses Next Generation Science Standards (NGSS) and CCSS, how the unit fits into a K–12 science curriculum program, and the prerequisite knowledge that students are expected to bring.

Next Generation Science Standards (NGSS)

Performance Expectations

Students' experiences with the *Pushes and Pulls* unit will support progress toward the five Performance Expectations listed below, with a particular focus on the first four. In the unit, students take on the role of pinball engineers as they explore the effects of forces on the motion of an object. Students conduct tests with their own prototypes (models) of a pinball machine and use what they learn to contribute to the design of a Class Pinball Machine. Note that students will get experience with the practices and crosscutting concepts represented in these Performance Expectations across many units in the Amplify Science K–8 curriculum program.

Performance Expectations Addressed

- **K-PS2-1. Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.** [Clarification Statement: Examples of pushes or pulls could include a string attached to an object being pulled, a person pushing an object, a person stopping a rolling ball, and two objects colliding and pushing on each other.] [Assessment Boundary: Assessment is limited to different relative strengths or different directions, but not both at the same time. Assessment does not include non-contact pushes or pulls such as those produced by magnets.]
- **K-PS2-2. Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.** [Clarification Statement: Examples of problems requiring a solution could include having a marble or other object move a certain distance, follow a particular path, and knock down other objects. Examples of solutions could

include tools such as a ramp to increase the speed of the object and a structure that would cause an object such as a marble or ball to turn.] [Assessment Boundary: Assessment does not include friction as a mechanism for change in speed.]

- **K-2-ETS1-1. Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.**
- **K-2-ETS1-2. Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.**
- **K-2-ETS1-3. Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.**

Science Practices

As with all Amplify Science units, the *Pushes and Pulls* unit provides students with exposure to most of the eight science and engineering practices described in the NGSS. This unit emphasizes the following practices (listed in order of particular emphasis), providing students with explicit instruction and expectations for increasing independence over the course of the unit.

- **Practice 6: Constructing Explanations and Designing Solutions.** Working as pinball engineers, students engage in all stages of an iterative cycle of design cycle as they learn, plan, make, and test. Then, based on the evidence they gather, they repeat the cycle. As students engage in these practices to design solutions for the Class Pinball Machine, they stop at various points throughout the unit to reflect on how they have participated in different engineering practices.
- **Practice 8: Obtaining, Evaluating, and Communicating Information.** Students read and search for evidence in a variety of books that are custom written for this unit. They receive explicit instruction and have multiple opportunities to use the reading comprehension strategy of visualizing as they engage with the five texts in the unit. This strategy promotes active engagement with ideas in each book.
- **Practice 4: Analyzing and Interpreting Data.** Students have multiple opportunities to analyze the data they collect from firsthand investigations with their Box Models as they test their ideas about how to exert forces on the pinball to cause it to move a certain way.
- **Practice 3: Planning and Carrying Out Investigations.** Students carry out multiple investigations to determine how to exert forces on the pinball to cause it to move a certain way.
- **Practice 2: Developing and Using Models.** Students use their Box Models to test ideas.
- **Practice 7: Engaging in Argument from Evidence.** Students make claims about what will work best for the Class Pinball Machine. Students support their claims with evidence they got while working with their Box Models.
- **Practice 1: Asking Questions and Defining Problems.** As students work with their Box Models, they refine their understanding of what a good pinball machine would need.

In all Amplify Science units, practices from the NGSS, CCSS-ELA, and CCSS-Math are linked. For instance, when students work to design the Class Pinball Machine; better understand the problems as they work; and make progress, piece by piece, they are engaging with the CCSS-Math Practice 1: Make sense of problems and persevere in solving them. When students visualize and explain the causal relationships between ideas in the investigations and/or science texts, they are developing the foundational capacity to build knowledge about a phenomenon through research and to respond analytically to informational sources, as called for by the CCSS-ELA Anchor Standards.

Disciplinary Core Ideas

Through students' focus on designing a pinball machine and explaining why the ball moves the way it does, students gain deep experience with the following core ideas:

PS2.A: Forces and Motion:

- Pushes and pulls can have different strengths and directions. (K-PS2-1) (K-PS2-2)
- Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it. (K-PS2-1) (K-PS2-2)

PS2.B: Types of Interactions:

- When objects touch or collide, they push on one another and can change motion. (K-PS2-1)

PS3.C: Relationship Between Energy and Forces:

- A bigger push or pull makes things speed up or slow down more quickly. (secondary to K-PS2-1)

ETS1.A: Defining Engineering Problems:

- A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions. (secondary to K-PS2-2)
- Asking questions, making observations, and gathering information are helpful in thinking about problems. (K-2-ETS1-1)
- Before beginning to design a solution, it is important to clearly understand the problem. (K-2-ETS1-1)

ETS1.B: Developing Possible Solutions:

- Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. (K-2-ETS1-2)

ETS1.C: Optimizing the Design Solution:

- Because there is always more than one possible solution to a problem, it is useful to compare and test designs. (K-2-ETS1-3)

Crosscutting Concepts

The crosscutting concept emphasized in the *Pushes and Pulls* unit is Cause and Effect. In their role as pinball engineers, students delve deeply into investigating the relationship between force and motion and use that information to design and build a Class Pinball Machine. Students conduct simple tests to gather evidence to support or refute their ideas about causes. Students return to the idea of cause and effect again and again throughout the unit, through a variety of modalities.

- **Do.** Students have multiple opportunities to investigate connections between observable causes and effects, such as seeing the effect of exerting a strong force or gentle force on a ball.
- **Talk.** Each investigation is followed by opportunities for student-to-student talk through which students develop an understanding of the mechanisms that connect those causes to their effects—exerting a gentle force results in moving the ball a shorter distance than exerting a strong force.
- **Read.** In *Forces in Ball Games*, the unit's reference book, students read about forces in different games that involve balls. Students analyze what caused a force to be exerted and the effect of that force.
- **Write.** Students write a mini-book that explains why the pinball moves the way it does. Students' explanations include a description of the effect of a specific kind of force that is exerted.
- **Visualize.** Throughout the unit, students focus on visualizing the movement that one might expect after a specific kind of force is exerted.

There are also opportunities to emphasize the crosscutting concepts of Structure and Function (e.g., students plan a pinball machine that will function in a certain way); Scale, Proportion, and Quantity (e.g., students compare the strength of the force they exert on the pinball); and Stability and Change (e.g., students figure out different ways to change the motion of the pinball in their Box Models).

How This Unit Fits Into the Amplify Science Program

The *Pushes and Pulls* unit is one of 3 20-lesson units for kindergarten. (Each unit also includes a pre-unit-assessment lesson and an end-of-unit-assessment lesson.) The 3 kindergarten units were designed to be taught in the following order:

- *Needs of Plants and Animals*
- *Pushes and Pulls*
- *Sunlight and Weather*

Trajectory of Core Ideas

Across the K–8 grade span, units are designed to support increasingly complex reasoning about forces and their interactions and the role that forces play in explaining phenomena.

In the kindergarten unit *Pushes and Pulls*, students develop an understanding of contact forces and the idea that when an object starts to move or changes direction, that is evidence that there was a force on that object.

In the grade 3 unit *Balancing Forces*, students expand their understanding of force to include non-touching forces. Students learn that more than one force can act on an object at a time and that forces can be acting on an object even when the object is stationary. Students also expand their understanding of forces by learning that any change in motion, including an object coming to rest, can be evidence of a force.

This broader, foundational understanding of forces sets up students for middle school when they begin to look at forces in a more relational way. In the *Force and Motion* unit, students look at forces through the relationship between force and the mass of an object and the change in velocity in a collision. In the *Magnetic Fields* unit, students look at forces through the relationship between force, potential energy, and position.

Focal Practice Trajectory: Engineering Design

Pushes and Pulls is one of the Amplify Science Elementary design units. Each unit in the elementary curriculum program focuses on a key practice of science or engineering. At each grade K–5, there is one investigation unit, one modeling unit, and one design unit. At each grade 3–5, there is also one unit that focuses on argumentation. The selected focus for a given unit depends on how the science content presents opportunities for students to conduct experiments, use models to investigate or represent their ideas, or apply knowledge to develop solutions. In designating a particular practice focus, we are not setting aside the other practices of science and engineering; rather, we are making some practices a more explicit focus with students. Students will still engage in other practices in this unit, but they are less explicitly called out. For example, while a design unit explicitly focuses students on creating solutions to problems, students also learn through scientific investigation, and they develop explanations that support solutions to the unit's problem.

Each Amplify Science unit that is focused on design also focuses on a specific aspect of the engineering-design practice, which we call a focal practice, and supports students in learning about and using that practice. For the *Pushes and Pulls* unit, that focal practice is **constructing a solution to a problem**. Engineers plan and construct solutions based on what they have learned. They test and evaluate their solutions and, based on their evaluations, they iterate, revising their solutions to better meet their goals. In each chapter of the unit, students revisit the problem of how to make a pinball machine. As students move up the elementary grades, they focus on important aspects of engineering practice in an intentional sequence. The *Pushes and Pulls* unit focuses students, in particular, on iteratively learning, constructing, and reconstructing a solution to a problem.

Engineering design involves a combination of applying science principles in order to design functional solutions and iteratively testing those solutions to determine how well they meet the design goals set by users or stakeholders. Design units make developing these solutions the central focus. Students construct an understanding of science ideas from investigation and text and apply those science ideas in designing solutions to an engineering problem. Students then test and/or evaluate their solutions to see how well they meet a set of design goals.

Prerequisite Knowledge

It is not required that students have any prerequisite knowledge coming into the *Pushes and Pulls* unit.

Common Core State Standards for English Language Arts (CCSS-ELA) Addressed in This Unit

The *Pushes and Pulls* unit includes many opportunities for students to address CCSS-ELA kindergarten standards focused on reading informational text, writing, speaking and listening, and language. The Amplify Science curriculum program engages students with the literacy practices they need in order to learn about science ideas, communicate their understanding, and engage in science practices. Through reading informational text, writing about science ideas, and discussing scientific concepts by using domain-specific vocabulary, students learn to use evidence from a variety of sources to build strong content understanding. Following is a list of those CCSS-ELA standards that are addressed multiple times throughout this unit.

Reading: Informational Text

- **CCSS.ELA-LITERACY.RI.K.1:** With prompting and support, ask and answer questions about key details in a text.
- **CCSS.ELA-LITERACY.RI.K.2:** With prompting and support, identify the main topic and retell key details of a text.
- **CCSS.ELA-LITERACY.RI.K.3:** With prompting and support, describe the connection between two individuals, events, ideas, or pieces of information in a text.
- **CCSS.ELA-LITERACY.RI.K.4:** With prompting and support, ask and answer questions about unknown words in a text.
- **CCSS.ELA-LITERACY.RI.K.5:** Identify the front cover, back cover, and title page of a book.
- **CCSS.ELA-LITERACY.RI.K.7:** With prompting and support, describe the relationship between illustrations and the text in which they appear (e.g., what person, place, thing, or idea in the text an illustration depicts).
- **CCSS.ELA-LITERACY.RI.K.10:** Actively engage in group reading activities with purpose and understanding.

Writing

- **CCSS.ELA-LITERACY.W.K.2:** Use a combination of drawing, dictating, and writing to compose informative/explanatory texts in which they name what they are writing about and supply some information about the topic.

- **CCSS.ELA-LITERACY.W.K.7:** Participate in shared research and writing projects (e.g., explore a number of books by a favorite author and express opinions about them).
- **CCSS.ELA-LITERACY.W.K.8:** With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question.

Speaking and Listening

- **CCSS.ELA-LITERACY.SL.K.1:** Participate in collaborative conversations with diverse partners about kindergarten topics and texts with peers and adults in small and larger groups.
  - **CCSS.ELA-LITERACY.SL.K.1.A:** Follow agreed-upon rules for discussions (e.g., listening to others and taking turns speaking about the topics and texts under discussion).
  - **CCSS.ELA-LITERACY.SL.K.1.B:** Continue a conversation through multiple exchanges.
- **CCSS.ELA-LITERACY.SL.K.2:** Confirm understanding of a text read aloud or information presented orally or through other media by asking and answering questions about key details and requesting clarification if something is not understood.
- **CCSS.ELA-LITERACY.SL.K.4:** Describe familiar people, places, things, and events and, with prompting and support, provide additional detail.

Language

- **CCSS.ELA-LITERACY.L.K.4:** Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on kindergarten reading and content.
- **CCSS.ELA-LITERACY.L.K.6:** Use words and phrases acquired through conversations, reading and being read to, and responding to texts.

Common Core State Standards for Mathematics (CCSS-Math) Addressed in This Unit

The *Pushes and Pulls* unit includes opportunities for students to engage in CCSS-Math standards. Additionally, you will find Going Further: Mathematical Thinking notes (located in the Teacher Support tab in the instructional guide) at selected spots in the unit that provide ideas for extension activities. Extension activities will allow students to further develop mathematical language related to describing, counting, classifying, and comparing measurable attributes of objects as well as identifying various shapes.

Math Practices

- **CCSS.MATH.PRACTICE.MP1:** Make sense of problems and persevere in solving them.
- **CCSS.MATH.PRACTICE.MP2:** Reason abstractly and quantitatively.
- **CCSS.MATH.PRACTICE.MP4:** Model with mathematics.

- CCSS.MATH.PRACTICE.MP6: Attend to precision.

Math Content

Counting and Cardinality

- CCSS.MATH.CONTENT.K.CC.5: Count to answer "how many?" questions about as many as 20 things arranged in a line, a rectangular array, or a circle, or as many as 10 things in a scattered configuration; given a number from 1-20, count out that many objects.

Measurement and Data

- CCSS.MATH.CONTENT.K.MD.1: Describe measurable attributes of objects, such as length or weight. Describe several measurable attributes of a single object.
- CCSS.MATH.CONTENT.K.MD.2: Directly compare two objects with a measurable attribute in common, to see which object has "more of"/"less of" the attribute, and describe the difference. For example, directly compare the heights of two children and describe one child as taller/ shorter.
- CCSS.MATH.CONTENT.K.MD.3: Classify objects into given categories; count the numbers of objects in each category and sort the categories by count. (Limit category counts to be less than or equal to 10.)

Geometry

- CCSS.MATH.CONTENT.K.G: Identify and describe shapes (squares, circles, triangles, rectangles, hexagons, cubes, cones, cylinders, and spheres).
- CCSS.MATH.CONTENT.K.G.1: Describe objects in the environment using names of shapes, and describe the relative positions of these objects using terms such as above, below, beside, in front of, behind, and next to.
- CCSS.MATH.CONTENT.K.G.4: Analyze and compare two- and three-dimensional shapes, in different sizes and orientations, using informal language to describe their similarities, differences, parts (e.g., number of sides and vertices/"corners") and other attributes (e.g., having sides of equal length).

Grade K: *Pushes and Pulls: Designing a Pinball Machine*

Overview of the Progress Build

A Progress Build describes the way in which students' explanations of the central phenomenon should develop and deepen over the course of a unit. It is an important tool in understanding the design of the unit and in supporting students' learning. A Progress Build organizes the sequence of instruction, defines the focus of the assessments, and grounds inferences about students' understanding of the content, specifically at each of the Critical Juncture Assessments found throughout the unit. A Critical Juncture is the differentiated instruction designed to address specific gaps in students' understanding. This overview document will serve as an overview of the *Pushes and Pulls: Designing a Pinball Machine* Progress Build. Since the Progress Build is an increasingly complex yet integrated explanation, we represent it below by including the new ideas for each level in bold. Depending on the standards for a given grade level, a unit may include additional supporting content; however, the Progress Build serves as the conceptual core of the unit.

In the *Pushes and Pulls* unit, students will learn to construct scientific explanations that describe the different ways that an object moves as caused by different forces exerted on the object. In particular, students will focus on investigating and explaining the different distances and directions that a pinball can be made to move in a pinball machine.

Assumed prior knowledge and experience: There is no significant prior knowledge assumed. Students will certainly have experience with observing moving objects, including rolling balls, as well as making objects move in different ways. Students will have experience moving objects by pushing or pulling, but they likely have not thought carefully about how those objects do so. Students will have opportunities to explore these kinds of actions more carefully over the course of the unit.

Progress Build Level 1: An object starts moving when a force is exerted on it.
When an unmoving object starts to move, it is because another object exerted a force on it.

Progress Build Level 2: Stronger force causes an object to move a longer distance.
When an unmoving object starts to move, it is because another object exerted a force on it. **A strong force will cause the object to move a long distance, while a gentle force will cause the object to move a short distance.**

Progress Build Level 3: An object starts to move in the direction of the force exerted on it.
When an unmoving object starts to move, it is because another object exerted a force on it. A strong force will cause the object to move a long distance, while a gentle force will cause the object to move a short distance. **The object starts moving in the same direction as the force that was exerted on it.**

Progress Build Level 4: Moving objects can change direction because of a force from a moving or still object.

When an unmoving object starts to move, it is because another object exerted a force on it. A strong force will cause the object to move a long distance, while a gentle force will cause the object to move a short distance. The object starts moving in the same direction as the force that was exerted on it. **If the object changes the direction it is moving, it is because a moving or still object exerted a force on it.**

Grade K: *Pushes and Pulls: Designing a Pinball Machine*

Overview of Unit Assessments

The Assessment System in the Amplify Science curriculum prioritizes the formative role that assessment may play in gathering actionable information about students' progress toward meaningful learning goals. The learning goals include constructing conceptual understanding (disciplinary core ideas and crosscutting concepts) and developing dexterity with targeted science and engineering practices. Assessments are grounded in the unit's Progress Build, which describes the way students' understanding of the unit's content should develop and deepen over the course of the unit's learning experiences. (For more detail about the Progress Build for the *Pushes and Pulls* unit, see Overview of the Progress Build in Unit Overview in the instructional guide.)

Each unit in the Amplify Science K–1 curriculum program includes a discussion-based opportunity to gain insight into students' incoming ideas in the first lesson and another opportunity to assess their understanding at the end of the unit. The Assessment System also includes a range of assessment opportunities embedded in instruction throughout the unit. On-the-Fly Assessments help teachers monitor students' learning progress on a lesson-by-lesson basis. Foremost among the on-the-fly opportunities are those that inform the Critical Juncture decision points in each chapter, as indicated in the Critical Junctures at a Glance table on page 3. Critical Juncture decision points draw on multiple sources of information about students' learning, including identified On-the-Fly Assessments, to inform a decision about whether and how to adapt instruction to address gaps in students' understanding before proceeding with instruction.

Also included in each K–1 unit is the Clipboard Assessment Tool. The Clipboard Assessment Tool is intended to offer teachers a support for conducting brief, talk-based checks that reveal students' thinking and correspond to the level of the Progress Build. The Clipboard Assessment Tool is provided at least once in each chapter (in Digital Resources) and includes tailored sets of questions and the specific activities that present an opportunity to ask those questions. Also included is space to write notes about students' ideas.

Pre-Unit and End-of-Unit Assessments

Pre-Unit Assessment: Explaining Why the Pinball Moves in Different Ways

In Lesson 1.1, students view a video of a homemade pinball machine in which the pinball moves in different directions with different amounts of force around the pinball machine. Students share their ideas—first in pairs and then as a class—about what made the pinball move in different ways. This pre-unit assessment is an opportunity for students to articulate their initial ideas. This will allow the teacher to draw connections to students' experiences and to watch for alternate conceptions that might get in the way of students' understanding.

In Guide to Interpreting Students' Pre-Unit Explanations: Explaining Why the Pinball Moves in Different Ways (in Digital Resources for Lesson 1.1), guidance is provided to help the teacher draw insights into students' initial thinking about the content. Included are examples of students' experiences that the teacher can connect to activities in the unit, ideas students may have about forces on which they can build, and alternate conceptions to address or watch out for.

End-of-Unit Assessment: Explaining the Movement of the Pinball in the Class Pinball Machine

In Lesson 6.3, the teacher sits with students, one at a time, and prompts them to explain how the ball moves to various locations in the Class Pinball Machine. These one-on-one assessment conversations are an opportunity to assess students' progress toward the core learning goals of the unit as specified in the Progress Build and to provide evidence of students' growth over time when compared with their responses from the pre-unit assessment. These conversations also reveal students' developing facility with the Next Generation Science Standards' (NGSS) practice of constructing solutions (based on design goals) and students' application of the crosscutting concept of cause and effect.

In the Guide to Assessing Students' Culminating Explanations: Explaining the Movement of the Pinball in the Class Pinball Machine (in Digital Resources for Lesson 6.3), rubrics are provided for assessing students' responses along several dimensions. These dimensions include attention to students' knowledge of how an object moves in a particular way due the force exerted, as well as students' understanding of the crosscutting concept of cause and effect and their developing facility with supporting an explanation with evidence.

Critical Juncture Assessments

Critical Junctures signify points in the unit at which it is especially important that all students understand the content before continuing. Critical Junctures are structured according to the levels of the Progress Build. Students should be able to demonstrate understanding at:

- Level 1 of the Progress Build by the end of Lesson 1.5.
- Level 2 of the Progress Build by the end of Lesson 2.3.
- Level 3 of the Progress Build by the end of Lesson 3.3.
- Level 4 of the Progress Build by the end of Lesson 4.3

However, there are many reasons that this may not be the case (from differences in students' background knowledge to students missing class). Therefore, Critical Juncture Assessments are designed to provide formative information about the actual level at which each student understands the content by the end of each of the lessons indicated above. These embedded assessments are opportunities to talk with students about their work and ideas by using questions associated with specific activities; these questions are included in the Clipboard Assessment Tool in the appropriate lessons. Each Critical Juncture Assessment includes specific suggestions for how to tailor instructional opportunities so they are targeted to a student's current level of understanding.

The goal of the suggested instructional activities is to ensure that all students reach a level on the Progress Build from which they can all continue on together. The at-a-glance table below indicates when in the unit each Critical Juncture Assessment occurs and its focus. The second table, Critical Junctures in Depth (pages 4–7), offers a more detailed look at how students' progress is assessed and how instruction may be tailored to support the learning of all students.

Critical Junctures at a Glance

Critical Juncture	Assessment focus
Critical Juncture Assessment 1: Students' Understanding of Movement as Caused By a Force (Lesson 1.5, Activity 4)	• understanding the cause–and–effect relationship between force and motion • modeling scientific phenomena
Critical Juncture Assessments 2a and 2b: Students' Understanding That a Stronger Force Moves an Object a Longer Distance (Lesson 2.3, Activities 1 and 2)	• understanding how varying the strength of a force impacts an object's motion • constructing oral explanatory accounts of phenomena
Critical Juncture Assessment 3: Students' Understanding of Movement in a Direction as Caused by a Force in That Direction (Lesson 3.3, Activity 3)	• cause and effect • understanding the causal relationship between the direction of a force on an object and the direction of that object's movement
Critical Juncture Assessment 4: Students' Understanding of Redirection as Caused By Forces (Lesson 4.3, Activity 2)	• developing a unified understanding of the relationship between force and motion • understanding how still or moving objects can apply forces to cause an object's motion to change

Critical Junctures in Depth

Lesson	Critical Junctures in *Pushes and Pulls*
Lesson 1.5, Activity 4	**Critical Juncture Assessment 1: Students' Understanding of Movement as Caused By a Force** **Assess understanding:** Questioning students as they talk is an additional opportunity for you to assess their understanding that an object starts moving because a force was exerted on it by another object. The questions included with the Chapter 1: Clipboard Assessment Tool for this lesson (*What is the object that started to move in the picture? Why did it start to move?*) are available as a reference. There is also a space to record notes about several students' responses. In general, students who understand these ideas should be able to explain that the moving object in the picture started to move because the other object exerted a force on it. **Tailor instruction:** Review your notes about students' responses from this activity and from On-the-Fly Assessment 3 in Lesson 1.4. If many of your students are not showing evidence of understanding that an object starts moving because a force was exerted on it by another object, we recommend offering additional instruction in Lesson 2.1. In the first activity of Lesson 2.1, you can take time for more focused instruction by using the objects from the Investigating Forces activity in Lesson 1.3. You can create three or four stations, each featuring a pair of objects where one is used to move the other. (See the Augmenting Instruction: Differentiating in Response to Critical Juncture Assessment 1 note in the Teacher Support tab in that activity for details.) If a smaller number of your students are not showing evidence of understanding those ideas, you can lead a similar discussion with just those students, before or during Lesson 2.1.
Lesson 2.3, Activity 1	**Critical Juncture Assessment 2a: Students' Understanding That a Stronger Force Moves an Object a Longer Distance** **Assess understanding:** Questioning students as they work on their Box Models in Activity 1 (and as they complete their diagrams in Activity 2) provides an opportunity for you to assess their understanding that a strong force causes an object to move a long distance, and a gentle force causes an object to move a short distance. The Chapter 2: Clipboard Assessment Tool is available as a reference for the key questions you can ask students during Activity 1 (*How does your Box Model make the ball go different distances? What is the force like when it goes a long distance? What is the force like when it goes a short distance?*). It is also a place to record notes about students' responses. In general, students who understand these ideas should describe what they do to make the ball move a short or long distance. They should also explain that the force is strong when the ball moves a long distance and gentle when the ball moves a short distance.

Lesson	Critical Junctures in *Pushes and Pulls*
Lesson 2.3, Activity 1	(continued) **Tailor instruction:** Wait to review your notes about students' responses from this activity and from On-the-Fly Assessment 5 in Lesson 2.2 until you have gathered additional notes about students' responses from Activity 2 in this lesson. (See Critical Juncture Assessment 2b: Students' Understanding That a Stronger Force Moves an Object a Longer Distance.)
Lesson 2.3, Activity 2	**Critical Juncture Assessment 2b: Students' Understanding That a Stronger Force Moves an Object a Longer Distance** **Assess understanding:** Questioning students as they complete their diagrams in Activity 2 provides additional opportunities for you to assess their understanding that a strong force causes an object to move a long distance, and a gentle force causes an object to move a short distance. The Chapter 2: Clipboard Assessment Tool is available as a reference for the key question you can ask students during Activity 2 (*What was the force like when the ball went a short or long distance?*). In general, students who understand these ideas should should say that the force was strong when the ball went a long distance and gentle when it went a short distance. **Tailor instruction:** Review your notes about students' responses during Activities 1 and 2 and On-the-Fly Assessment 5 from Lesson 2.2. If many of your students are still not showing evidence of understanding that a stronger force moves an object a longer distance, we recommend offering additional instruction in Lesson 3.3, Activity 1. In that lesson/activity, take time for targeted instruction about strong and gentle forces. (See the Augmenting Instruction: Differentiating in Response to Critical Juncture Assessments 2a and 2b note in the Teacher Support tab in that activity for more information.) If a smaller number of students are not showing evidence of understanding those ideas, you can lead a similar discussion with a smaller group.

Lesson	Critical Junctures in *Pushes and Pulls*
Lesson 3.3, Activity 3	**Critical Juncture Assessment 3: Students' Understanding of Movement in a Direction as Caused by a Force in That Direction** **Assess understanding:** Listening to and questioning students as they make predictions and try to hit the targets is an opportunity for you to assess their understanding of movement in a direction as caused by a force in that direction. The questions included with the Chapter 3: Clipboard Assessment Tool for this lesson (*You want the ball to go _____. What will the force you exert need to be like to make it move that way? The ball went _____. What was the force that you exerted on it like to make it move that way?*) are available as a reference. There is also a space to record notes about several students' responses. In general, students who understand should say that the force should be in the direction that they want the ball to go. They should also say that the force was in the direction that the ball moved. **Tailor instruction:** Review your notes about students' responses from this activity and from On-the-Fly Assessment 7 from Lesson 3.2. If many of your students are not showing evidence of understanding movement in a direction as caused by a force in that direction, we recommend offering additional instruction in Lesson 3.4, Activity 3. In that lesson/activity, you will take time to coach students in thinking about the direction of forces by modeling how to diagram making the ball move to a certain place. (See the Augmenting Instruction: Differentiating in Response to Critical Juncture Assessment 3 note in the Teacher Support tab in that activity for more information.) If a smaller number of your students are not showing evidence of understanding those ideas, you can lead a similar discussion with a small group while the class is working on their diagrams.
Lesson 4.3, Activity 2	**Critical Juncture Assessment 4: Students' Understanding of Redirection as Caused By Forces** **Assess understanding:** Students' marking forces in their diagrams is an opportunity for you to assess their understanding that when a moving object changes direction, it is because a moving or still object exerted a force on it. The Chapter 4: Clipboard Assessment Tool is available as a reference for the relevant questions (*Where was the force exerted on the ball? Why do you think that is a place where a force was exerted? What is your evidence?*) are available as a reference. There is also a space to record notes about several students' responses. In general, students who understand should draw an "X" on their diagrams to represent the place in their Box Models that touched the ball. They should say that they know a force was exerted there because the ball started to move or changed direction (e.g., launcher/ball started to move, flipper/ball changed direction, bumper/ball changed direction).

Lesson	Critical Junctures in *Pushes and Pulls*
Lesson 4.3, Activity 2	(continued) **Tailor instruction:** If many of your students are not showing evidence of understanding redirection caused by a force from a moving or still object, we recommend offering additional instruction in Lesson 5.2, Activity 3. In that lesson, you will take time to highlight the two design goals focused on changing direction and prompt students to think about how forces are involved in changing direction. (See the Augmenting Instruction: Differentiating in Response to Critical Juncture Assessment 4 note in the Teacher Support tab in that activity for more information.) If a smaller number of your students are not showing evidence of understanding those ideas, you can lead a similar discussion with a small group.

On-the-Fly Assessments

On-the-Fly Assessments are quick checks for understanding designed to help the teacher monitor and support students' progress throughout the unit. On-the-Fly Assessments are provided for multiple lessons in each chapter and represent the most opportune moments for a glimpse into students' developing conceptual understanding and their facility with the practices. Each On-the-Fly Assessment indicates the specific concepts and practices to look for or listen for as students engage with the learning experiences, followed by suggestions to the teacher of what to do, based on what was observed. These formative assessments are embedded in the instruction and do not require formal scoring of students' work. The at-a-glance table (pages 7–9) provides information about the focus of each On-the-Fly Assessment in order to support teachers in selecting the formative assessment opportunities that make the most sense for their situations. The second table, On-the-Fly Assessments in Depth (pages 10–19) , offers a more detailed look at what to look for and next steps.

On-the-Fly Assessments at a Glance

On-the-Fly Assessment	Assessment focus
On-the-Fly Assessment 1: Students' Initial Use of Visualizing Scientific Phenomena (Lesson 1.2, Activity 2)	• visualizing scientific phenomena • making careful observations
On-the-Fly Assessment 2: Using Scientific Language While Investigating Forces (Lesson 1.3, Activity 2)	• using scientific language • investigating force and motion
On-the-Fly Assessment 3: Identifying the Cause of Movement in Students' Box Models (Lesson 1.4, Activity 4)	• cause and effect • identifying the force that causes an object's motion

On-the-Fly Assessment	Assessment focus
On-the-Fly Assessment 4: Systematically Investigating Force and Motion (Lesson 2.1, Activity 2)	• conducting systematic investigations • varying one thing at a time • understanding how varying the strength of a force impacts an object's motion
On-the-Fly Assessment 5: Understanding That Different Size Forces Have Different Effects on an Object's Movement (Lesson 2.2, Activity 3)	• understanding how varying the strength of a force impacts an object's motion • constructing oral explanatory accounts of phenomena
On-the-Fly Assessment 6: Visualizing Direction of Movement By Using Images (Lesson 3.1, Activity 3)	• visualizing scientific phenomena • making careful observations
On-the-Fly Assessment 7: Understanding the Causal Relationship Between the Direction a Force Is Applied and the Direction of Movement (Lesson 3.2, Activity 3)	• cause and effect • understanding the causal relationship between the direction of a force on an object and the direction of that object's movement
On-the-Fly Assessment 8: Students' Exploration of Hitting a Certain Target (Lesson 3.4, Activity 2)	• conducting systematic investigations • using test data about an object's movement to adjust application of force
On-the-Fly Assessment 9: Visualizing and Discussing Both Direction and Force (Lesson 3.5, Activity 3)	• visualizing scientific phenomena • engaging in scientific discourse about force and motion, cause and effect • constructing oral explanatory accounts of observed phenomena
On-the-Fly Assessment 10: Visualizing and Discussing Change of Direction (Lesson 4.1, Activity 3)	• visualizing scientific phenomena represented in photographs and texts • applying science ideas to interpret visual and textual information
On-the-Fly Assessment 11: Connecting Reading to Rugball to Explain Force and Motion (Lesson 4.2, Activity 2)	• making connections between reading and hands-on investigations • constructing oral explanations of force and motion
On-the-Fly Assessment 12: Making Planned Changes to the Box Model (Lesson 5.1, Activity 4)	• designing solutions • iterating on a design based on test data • using diagrams to guide model designs

On-the-Fly Assessment	Assessment focus
On-the-Fly Assessment 13: Evaluating Solutions Based on Pinball Machine Design Goals (Lesson 5.2, Activity 3)	• evaluating solutions based on design goals
On-the-Fly Assessment 14: Using Scientific Language During the Showcase (Lesson 5.3, Activity 1)	• using scientific language to describe student models
On-the-Fly Assessment 15: Providing Evidence of Forces (Lesson 6.1, Activity 3)	• understanding of motion as evidence of a force being exerted • applying science ideas to new contexts

On-the-Fly Assessments in Depth

Lesson	On-the-Fly Assessments in *Pushes and Pulls*
Lesson 1.2, Activity 2	**On-the-Fly Assessment 1: Students' Initial Use of Visualizing Scientific Phenomena** **Look for:** The focal comprehension strategy in this unit is visualizing by using information read or seen in books. As students are talking about the movements they visualize based on the projected images, listen for and make note of individual students or partners who are attending to particular elements in an image and using talk or gestures to describe how they imagine the elements moving. For example, a student might say something such as *I think the cow is pulling the wagon and making the wagon move on the road. The cow's legs look like the cow is taking a step. The cow is hooked to the wagon, so it pulls the wagon, and the wheels are turning round and round.* **Now what?** As you reflect on the activity with the class, repeat one or two accurate examples of visualizing that you noticed in students' talk. Highlight the way that students took what could be seen in the images and then went beyond it in describing movement. For example, you might say something such as *I noticed Rosa's example of visualizing with this picture. She noticed how the cow's legs were forward and imagined the cow taking a step. She saw that the cow is hitched to the wagon, so she imagined the wagon rolling forward on its wheels as the cow walked. Good visualizing takes what is in a picture or words and uses those things to imagine something more.* If students generally had difficulty visualizing, pick another image and model visualizing particular movement based on specific elements in the image.
Lesson 1.3, Activity 2	**On-the-Fly Assessment 2: Using Scientific Language While Investigating Forces** **Look for:** Students' exploration of forces between objects in this activity is an opportunity to assess their initial efforts to incorporate two new terms that will be useful in discussion throughout the unit—*force* and *exert*. As partners are exploring, listen to their talk or prompt them to share their ideas about why an object is starting to move. In general, students should explain that one object exerts a force on the other object to make it move (e.g., *The metal thing moves when the string exerts a force on it.*) Students who are still developing a proficiency with the words force and exert may give more colloquial descriptions (e.g., *The metal thing moves when the string pulls it.*) or hybrid versions (e.g., *The metal thing moves when the string exerts a pull.*).

Lesson	On-the-Fly Assessments in *Pushes and Pulls*
Lesson 1.3, Activity 2	(continued) **Now what?** If you notice many students who are not incorporating the words *force* and *exert* into their talk, you can take a few minutes to explicitly model and then support students in revising the way they talk about the interactions between the objects. Select two or three interactions that you noticed students trying out in their explorations (e.g., the shoelace pulling the metal nut, the wooden stick pushing the flat marble). Demonstrate an interaction where students can see it and narrate what you are doing in colloquial terms (e.g., *I am looping the shoelace through the hole in the metal nut and pulling on the lace. The metal nut slides across the table.*). Remind students that this is a fine way to talk about what is going on here, but scientists and engineers use different words. Explain that it is important for scientists and engineers to think about how things that might seem different are actually the same in some way. Also explain that, for example, pushes, pulls, and hits look different from one another, but they are also the same because they can all make something start to move. As scientists and engineers, when we see one object push, pull, or hit another object, we say that one object exerted a force on another object. Using those words shows that we know they are all the same kind of thing. Revise and restate your original description of the interaction by using force and exert (e.g., *The metal nut moves across the table when the lace exerts a force on it.*) Demonstrate another interaction and give a colloquial description. Ask partners to revise what you said by using the words force and exert. Invite a student to share with the class. Repeat with other interactions if you want to provide additional practice.
Lesson 1.4, Activity 4	**On-the-Fly Assessment 3: Identifying the Cause of Movement in Students' Box Models** **Look for:** Students' creation of their Box Model diagrams is an opportunity to assess their understanding that something starts to move when something else exerts a force on it. The questions included with the Chapter 1: Clipboard Assessment Tool for this lesson (*What are you showing in your diagram? Why did the ball start to move?*) are available as a reference. There is also a space to record notes about several students' responses. In general, students who understand should explain how the ball started at one point and moved to another point. Students should explain that because they pulled the rubber band and let it go, the rubber band exerted a force. **Now what?** If you notice students who do not show evidence of understanding movement as caused by a force from another object, be sure to note which students and how many. These observations will help you make a decision about whether to tailor instruction after the Critical Juncture in Lesson 1.5.

Lesson	On-the-Fly Assessments in *Pushes and Pulls*
Lesson 2.1, Activity 2	**On-the-Fly Assessment 4: Systematically Investigating Force and Motion** **Look for:** Even in exploratory investigations, an important part of science is intentionally changing one thing at a time in order to observe its effect on another thing. As students are exploring, pay attention to the things they are doing or saying that indicate a level of intentionality in their exploration. You may notice that students are paying careful attention to the ball's movement as a result of their pushes or hits and that they are intentionally changing their actions in future trials as a result of what they noticed. For example, you might see a student hit the ball sharply, observe that it substantially overshoots the shoelace that is marking the short distance, and then nudge the ball much more gently in her second attempt. Or, you might see a student trying to replicate the motion of a successful push from a previous turn by himself or his partner. You may also hear students say things that reflect this kind of thinking (e.g., *It went long. This time, I'm going to just touch it a little.*). If students are not being intentional, the distances the ball travels may appear repetitive or random, and they may not appear to be trying to regulate the way that they push the ball. It's important to keep in mind that students may not yet have the physical motor control to be very precise in adjusting or replicating their movements. What is important is that they are thoughtful in their attempts. **Now what?** If it seems that students are not being intentional in their explorations, you can guide more intentional thinking with a few students as they are exploring. For example, you can support a student in attending to the distance the ball traveled and how she might change how she pushes it (e.g., *That time the ball went a long distance, it went far past the string. How will you change what you do this time so it does not go so far?*) Additionally, when you gather for Rugball in Activity 3, you can highlight what students were doing well or invite them to share how they tried to change what they did to make the ball move a shorter or longer distance (e.g., *I noticed that some students were looking carefully at how far the ball moved and then trying to do something different that would make it move a longer or shorter distance. That's an important part of science and engineering—carefully exploring how one thing changes another—what she does to the ball changes how far the ball moves.*)

Lesson	On-the-Fly Assessments in *Pushes and Pulls*
Lesson 2.2, Activity 3	**On-the-Fly Assessment 5: Understanding That Different Size Forces Have Different Effects on an Object's Movement** **Look for:** The Forces card-sort activity is an opportunity to assess students' understanding that an object moves a long distance when a strong force is exerted on it, and an object moves a short distance when a gentle force is exerted on it. The question included with the Chapter 2: Clipboard Assessment Tool for Lesson 2.2 (*Why did you decide to put this card under the Strong Force or Gentle Force header?*) is available as a reference. There is also a space to record notes about several students' responses. In general, students who understand should point out the distance that the object moved in each example. They should explain that the force was strong when it went a long distance and that the force was gentle when it went a short distance. **Now what?** If you notice students who do not show evidence of a stronger force moving an object a longer distance, be sure to note which students and how many. These observations will contribute to the Critical Juncture decision in Lesson 2.3.
Lesson 3.1, Activity 3	**On-the-Fly Assessment 6: Visualizing Direction of Movement By Using Images** **Look for:** The focal comprehension strategy in this unit is visualizing by using information read or seen in books. In the Partner Read, students are specifically asked to use the still photographs in the book to visualize the different directions of movement in which the construction workers would be engaging. As you circulate, observe students as they pantomime or talk about directions: up, down, left, right, and toward and away from themselves. Note if students are able to use clues from the pictures as well as their prior knowledge, (e.g., how to use a hammer) to visualize the movement and the direction of the movement that would happen. **Now what?** If students are unsure of the movement indicated in the picture, ask them to describe what they see in the picture (e.g. *I see a hammer. I see a nail. She is holding the hammer.*) and then ask "What do you think is moving?" "What is the construction worker doing to make it move?" "What would it look like if you were doing what she is doing?" If students do not have the language to describe the direction in which the movement is happening, note the difficulty and encourage students to point in the direction they think the movement is happening or show the direction with a movement of their hands.

Lesson	On-the-Fly Assessments in *Pushes and Pulls*
Lesson 3.2, Activity 3	**On-the-Fly Assessment 7: Understanding the Causal Relationship Between the Direction a Force Is Applied and the Direction of Movement** **Look for:** Making the ball move in different directions in the Box Models is an opportunity to assess students' understanding of movement in a specific direction as caused by a force in that direction. The questions included with the Chapter 3: Clipboard Assessment Tool for this lesson (*How do you make the ball go in one direction or another direction? What is the force like when it goes to the ___?*) are available as a reference. There is also a space to record notes about several students' responses. In general, students who understand should demonstrate how they pull on the launcher string to make the ball go a particular direction. They should also say that the force is in the same direction that the ball moves. **Now what?** If you notice students who do not demonstrate understanding of movement in a specific direction as caused by a force in that direction, be sure to note which students and how many. These observations will help you make a decision about whether to tailor instruction after the Critical Juncture in Lesson 3.3.
Lesson 3.4, Activity 2	**On-the-Fly Assessment 8: Students' Exploration of Hitting a Certain Target** **Look for:** Students' efforts to make the pinball hit a certain target provide an opportunity to informally assess how they intentionally modify their launches based on their observations of how the ball moves. Revising a solution based on analysis of its performance is an important aspect of engineering practice. In general, students who use this practice will observe how close their balls are to hitting the targets and then make changes to how they launch the balls to improve their accuracy. This may mean that students will need to make several launches that go in the general direction of the target and get successively closer with each launch. You may want to ask students what they think they could do to make the next launch more accurate than the previous launch. **Now what?** If you notice that few students are doing these kinds of intentional modifications, you may want to briefly pause the activity and provide some guidance about how to make intentional modifications. Demonstrate a launch toward a particular target that is to one side or that overshoots or undershoots the target. Share with students that one thing that good engineers do is make changes by thinking about what they want and what actually happens. Model this process by thinking aloud: *I wanted the ball to hit the target, but it went off to the side. I will have to change the direction of the force so the ball moves in the right direction. Maybe pulling the launcher back to a different side will help.* You can also call attention to any things you noticed students doing that did reflect this kind of intentional modification.

Lesson	On-the-Fly Assessments in *Pushes and Pulls*
Lesson 3.5, Activity 3	**On-the-Fly Assessment 9: Visualizing and Discussing Both Direction and Force** **Look for:** Students visualize movement as they synthesize and apply a number of new ideas in order to describe or explain movement of the ball to a certain place. Listen as students describe what they noticed in the photographs in order to visualize movement. Support their ideas of how the ball moves to a certain place. For example, students may note that the ball is moving far, based on the ball looking blurry in the photograph. They may also note that the ball is being hit hard, based on the way the batter is moving his body. Or, they may notice impact, based on prior knowledge of a heavy bowling pin that can knock down pins. Also note if students are able to describe both the strength and direction of forces when talking about the ball games. **Now what?** If you notice that students need additional support to synthesize all these ideas, consider using any of the following supports during the activity or as students revisit the book at other times during the day. • Gather a small group for more guided work. • Create a checklist that mirrors the images on the What We Know About Forces chart to remind students to consider both strength and direction. • Call for students' attention after a few minutes of work time and ask volunteers to share examples they found. • Flag (with sticky notes) one or two clear examples in students' books ahead of time.
Lesson 4.1, Activity 3	**On-the-Fly Assessment 10: Visualizing and Discussing Change of Direction** **Look for:** The focal comprehension strategy in this unit is visualizing by using information read or seen in books. In the Partner Read, students are specifically asked to refer to the photographs in *Forces in Ball Game*s to visualize how and why the balls changed direction. As you circulate, observe students as they pantomime or talk about how and why the ball started to move in one direction and then changed to move in a different direction. Note if students are able to use clues from the pictures, as well as their prior knowledge, to help them as they discuss.

Lesson	On-the-Fly Assessments in *Pushes and Pulls*
Lesson 4.1, Activity 3	(continued) **Now what?** If students are unsure of the how the ball changed direction or how to describe how it changed direction, ask them to describe what they see in the photograph and invite them to pantomime how the ball started to move. Then, ask students in what direction the ball moved and have them trace (on the photograph) that direction. Continue with this line of questioning, asking what happened next to change the direction in which the ball moved and to specify the direction in which it moved. If students do not have the language to describe how the ball changed direction, note the difficulty and encourage students to pantomime playing each step of the game.
Lesson 4.2, Activity 2	**On-the-Fly Assessment 11: Connecting Reading to Rugball to Explain Force and Motion** **Look for:** The Rugball discussion presents an opportunity to informally assess students making connections between the examples of changing direction that the class read about in *Forces in Ball Games* and the examples they see during Rugball. After discussing a moving object that exerted a force and changed the ball's direction, notice if students share any similar examples they remember from their reading (e.g., the man hitting the foosball or the table-tennis paddle hitting the table-tennis ball). Again, after discussing a still object that exerted a force, note the examples that students share from the reading that relate (e.g., the basketball hitting the floor and bouncing back up). **Now what?** If you notice students having difficulty thinking of examples from the reading, you can pause the Rugball discussion to retrieve the book and look back at each example more carefully. Turn to the pages you read previously and briefly describe what happened. Alternatively, you can invite a volunteer to do it. Ask students to evaluate the example as the same or different: *Does this example describe a ball changing direction because of a force exerted by a moving object? Why do you think so?* If students are unsure, you can model one evaluation for them: *I think this is an example of a ball changing direction because of a force by a moving object. Just as the Rugball changed direction when the moving clipboard exerted a force on it, this ball changed direction when the moving foosball man exerted a force on it.*

Lesson	On-the-Fly Assessments in *Pushes and Pulls*
Lesson 5.1, Activity 4	**On-the-Fly Assessment 12: Making Planned Changes to the Box Model** **Look for:** Students' revisions of their Box Models present an opportunity to informally assess the construction of their solutions based on their initial plans. While engineers' solutions evolve as they test and revise them, constructing solutions based on a plan is a crucial engineering practice. As students construct their final Box Models, look for evidence that they are attending to their planning diagrams as they do so. In general, students should be looking to their plans as they add components to their Box Models and placing components in roughly the same place as they drew them in their diagrams. You may also want to ask students how they are using their plans to construct their models—differences that seem like departures from the plan to you may seem identical to them. **Now what?** If you notice that students are mostly building their Box Models without attention to their diagrams, you can briefly pause the activity to reaffirm the importance of building from a plan when designing a solution. You might model troubleshooting a solution that is different than your plan and relocating a component that is in a different place than the one shown in your plan.
Lesson 5.2, Activity 3	**On-the-Fly Assessment 13: Evaluating Solutions Based on Pinball Machine Design Goals** **Look for:** Students' testing of their Box Models presents an opportunity to informally assess their evaluations of their solutions' performances in relation to the design goals. In general, students should produce a particular movement in their models and then check (or not check) the corresponding design goal as appropriate. If students do not understand the purpose of evaluating or the function of the checklist, students might check off design goals regardless of whether the movement met the goal. Or, they might check off goals without doing anything in their Box Models. **Now what?** If many students are having difficulty, you may want to pause the activity and test a single design goal. Have students work with you as you all try to create a particular movement at the same time. Then, decide if it met the design goal. If you notice a few students having difficulty evaluating, take a minute to coach them by testing and evaluating a single design goal before having them continue on their own.

Lesson	On-the-Fly Assessments in *Pushes and Pulls*
Lesson 5.3, Activity 1	**On-the-Fly Assessment 14: Using Scientific Language During the Showcase** **Look for:** Students' interactions with their Box Models during the showcase present an opportunity to informally assess students' use of various engineering practices and scientific language. As they are talking about one another's Box Models, pay attention to whether or not students are asking and answering questions that help them clarify concepts. Also note if students are using causal language (___ *because* ___), the language of forces (*exert*, *force*, *gentle*, *strong*), and direction words (*long/short*, *left/right*). **Now what?** If you notice that many students are not using the kind of scientific language they have been practicing, pause the activity to offer explicit feedback and support. Pointing out visual supports (e.g., diagrams or images from classroom charts) or the explanation language frames may be good reminders for many students. You may also choose to highlight exemplary language used by students to explain their Box Models. Or, you can pair students with different language-proficiency levels so one partner can provide examples of appropriate scientific language. If you notice that a few students are not using the kind of scientific language they have been practicing, you can intervene individually or convene a small group to direct their attention to the classroom resources (e.g., explanation language frames, vocabulary cards, class charts).
Lesson 6.1, Activity 3	**On-the-Fly Assessment 15: Providing Evidence of Forces** **Look for:** Your questions during the School Forces Tour present an opportunity to informally assess students' understanding of motion as evidence of a force being exerted. In general, when you ask students for evidence of a force they've identified as exerted on an object, they should describe the movement of the object. They may also identify a more specific aspect of the force (e.g., strength, direction) and support it with evidence (e.g., distance traveled, direction moved), but it is most important that they describe movement as evidence of a force.

Lesson	On-the-Fly Assessments in *Pushes and Pulls*
Lesson 6.1, Activity 3	(continued) **Now what?** If you notice that students do not know how to respond when you invite them to offer evidence, you can do some prompting in the moment, scaffolding their responses. For example, you might say, *We know that when we see something start moving, stop moving, or change direction, that is evidence of a force. What do you see happening to the cart that is evidence that a force is exerted on it?* If students describe something other than movement as evidence (e.g., *I can see him pushing it.*), acknowledge their thinking and redirect their responses. For example, you could say, *Right. We have learned that pushing is one way that forces are exerted, and, in general, we know what a push looks like. What is most important to look for as evidence of a force is whether something moves—starts moving, stops moving, or changes direction. What do you see moving?* If you notice that a few students are not sure how to respond, you may want to pause in a place where you can see many moving objects, model identifying a force based on movement as evidence for the class, and invite students to identify others forces based on movement as evidence.

Student Self-Assessments

An important part of students' learning to learn well is developing a sense of their own ideas and thinking. Providing regular opportunities for even young students to assess their own learning can help develop students' habits of self-reflection, as well as support the development of their own theories of mind. Included toward the end of each chapter is a prompt for partners to verbally share at least one idea they have learned that they didn't know before. For example, in Lesson 1.5, the teacher summarizes the ideas students have learned about forces and then directs them in a paired self-assessment.

- *Our writing shows that we have figured out many new ideas about how things start to move. We have learned that the things we can see, touch, and move are called objects. We have learned that an object starts to move because a force is exerted on it. And we have learned that there are many different ways that forces can be exerted, such as pushing, pulling, throwing, and kicking.*

- *What is one idea that you know now that you did not know before? Take a moment to talk about this with a partner.*

This quick yet important activity asks students to reflect on how their own ideas have changed as a result of their learning activities. This lays an important foundation for students' thinking about ideas as things that can grow and change over time, based on their interactions with books, their peers, and the world around them.

Grade K: *Pushes and Pulls: Designing a Pinball Machine*

Science Background

The information in this section is for adults teaching the unit and expressly not meant as student-facing material. The *Pushes and Pulls: Designing a Pinball Machine* unit encompasses wide-ranging and sometimes complex physical science content, and the information provided in this document is far from a complete discussion of the topic. Within the limitations of this relatively brief summary, we strive for accuracy and clarity. For a summary description of what students are expected to learn about forces, see Overview of the Progress Build (in Unit Overview in the instructional guide).

The Nature of Forces

A Force Is a Push or a Pull Between Objects

The concept of force is central to the study of physics because forces govern the motion of objects. The definition of *force* can be stated very simply—a force is a push or a pull between objects. This simplicity of description is not shared by the concept of momentum (which must be described in terms of measurable quantities and mathematical relationships) or the concept of energy (which requires prolonged experience for students to make sense of it). However, there are some ideas about force that can be a bit tricky for students, as well as adults, to understand.

Note: It can be confusing for students to categorize every force as either a push or a pull. In practice, many examples of forces (e.g., people pulling one another's hands) involve multiple sets of forces, including pulls (e.g., bodies pulling apart) and pushes (e.g., fingers pushing together). Students draw from experiences like these as they formalize their knowledge of forces during this unit. It can be difficult to decide if something is a push or a pull when the objects neither get closer together nor get farther apart. For this reason, we do not ask students to classify forces as pushes or pulls, but focus rather on the movement caused by forces being exerted.

Forces Always Occur in Pairs

A force as an interaction between objects, a push or a pull that one object exerts on another as the two objects interact. In this unit, students apply forces onto still objects and moving objects to move them in specific ways. A force exerted on an object has both a strength and a direction, affecting the distance and direction the object travels. Forces always occur in pairs. Whenever an object exerts a force, it is always met by an equal and opposite force. This is the essence of Newton's Third Law of Motion.

Note: Forces exerted by moving objects are more immediately obvious to young students. Their experience exerting a force by performing an action (such as hitting, kicking, or pushing) supports a concrete understanding that a force from a moving object can make an object start to move, stop moving, or change direction. Forces exerted by still objects are more abstract, and can be surprising to some students. However, students have had direct experience with this idea. A ball bouncing off a wall or a floor is a familiar example of a force exerted by a still object on a moving one. When the ball hits the surface, it exerts a force on the surface while the surface exerts an equal and opposite force on the ball, causing it to change direction.

Forces Can Cause Changes in the Motion of an Object

While we cannot see forces, we can tell when a force is exerted by its observable effect. Forces change the way things move—or, in other words, when an object changes the way it is moving, that is evidence that a force is at work. If an object slows down, speeds up, or changes direction, then we know there was a force exerted on that object. This is often observed as a change in how something moves.

Note: Students spend time in this unit searching for and identifying evidence of forces. When students look for evidence of forces being exerted (mainly in the form of pushes and pulls by other students and adults) they cite that objects' movement as evidence that forces have been exerted. In the majority of examples, the force is still being exerted as students observe the motion. For example, as they watch another student push a marker, they are watching a force exerted in that moment. Students may find other examples, such as that same marker rolling across a table after being pushed by a person, that are evidence of a force being recently exerted. Young students are still developing the relational vocabulary that facilitates describing the past, and the nuance between these examples is often challenging for them to describe. Furthermore, as students work within their early conceptions of science ideas, identifying when a force is currently being exerted versus when it was recently exerted is not necessary. A foundational understanding of the relationship between movement and force prepares students to explore this distinction more deeply in later grades.

Friction and Inertia

For many years, scientists made the reasonable assumption that, without the exertion of a force, a moving object would slow down and come to rest. Many people still erroneously make this assumption. It is now recognized that if a moving object slows down and comes to rest, it is because of a force (friction), not because of a lack of force. Friction—the force between the moving object and the surface on which it is traveling (or the medium through which it is traveling)—is usually the force that slows down moving objects until they come to rest. When there is no friction (such as when an object is coasting through outer space), moving objects will keep moving without slowing down. When there is friction (such as when a wheel rolls on the ground), it takes a force that is equal and opposite to the force of friction to keep the object moving. In this unit, students have a variety of experiences rolling balls varying distances. As the balls slow and roll to a stop, students are observing the effect of friction.

Newton's First Law of Motion describes how objects move, as paraphrased here: *An object at rest stays at rest, and an object that is moving keeps moving in the same direction at the same speed, unless acted upon by an unbalanced force.* It can be helpful to think of objects as being "lazy," in the sense that an object resists changing its motion whether it is traveling at 100 mph or merely sitting at rest. This tendency of objects to keep doing what they are doing is referred to as *inertia*. A common example of inertia in everyday life is when you are riding in a car—moving at the same speed and direction of the car—and the driver suddenly puts on the brakes. As the car slows down, you feel the tendency of your body to keep moving forward until it is restrained by your seat belt. The seat belt provides the force to safely slow down your forward movement. While this interaction is advanced for kindergarteners to understand, it is helpful to understand when considering the idea that when an object is moving, this does not always indicate a force is being exerted on it.

Note: Typically, students think of a force only as something that makes things happen or creates a change. They believe forces only cause motion but do not stop it, and they often think there is no force acting on something if it is not moving. Since you cannot see forces, they are inherently abstract to kindergarten students. However, acting to make an object move and seeing its movement are concrete to young students. In an effort to reach a robust understanding of how forces start movement and change a moving object's direction, this unit's scope does not thoroughly address forces working to stop an object's motion.

Gravity

Forces happen between two objects. When an object rolls down a ramp or falls, it may seem as though the object moves without another object exerting a force on it. The force of gravity, however, is responsible for the movement. The object is moving down because a second object, Earth, is exerting a force on it. Gravity's effect on an object varies based on the object's properties. The strength of the force between two objects is greater when the mass (how much matter something is made of) of each object is greater. The strength of the force is also greater when the distance between the two objects is less. The way an object responds to the force of gravity depends on the object's mass and velocity (the speed of the object and the direction in which it is traveling). Gravity is different from the other forces explored in this unit. Gravity is a noncontact force, which means that objects experience the force of gravity even when they are not touching the object that is exerting the force (i.e., Earth). Contact forces (such as a foot kicking a ball or a ball bumping into a wall) end when the the two objects are no longer touching. The force of gravity on an object, however, is always being exerted by Earth—when the object is being held up, when it is falling, and when it is resting on the ground. Noncontact forces, such as gravity, are more abstract and are not introduced in this unit.

Cause and Effect: Mechanism and Explanation

Cause and effect is a crosscutting concept called out by the Next Generation Science Standards (NGSS) as one of seven ideas that are widely useful across scientific topics and disciplines. Events in the natural world have causes. Some of these causes are simple, while others are multifaceted. A fundamental part of scientists' work is developing an understanding of the causes that lead to observable effects. This understanding often starts by linking observable events together, recognizing that one leads to the other. For example, in London in the 1800s, English scientist John Snow used careful data collection and analysis to realize that cases of cholera were caused by people's use of a particular water pump for their drinking water.

However, scientists try to go beyond what is easily observable to describe the mechanism that connects the cause to the effect. Snow, while unsatisfied with the theories at the time, was not sure why drinking water from that pump caused cholera. It was not until the germ theory of disease was developed that scientists could propose a mechanism for the cause–and–effect relationship. Microorganisms that entered the water from a nearby cesspit infected people who drank the water from that particular water pump. The microorganisms multiplied inside people and caused their symptoms.

When scientists and engineers describe how causes lead to observable effects through particular mechanisms, they are constructing explanations. Understanding and explaining the causal mechanisms involved in one situation often allows them to explain or make predictions about new but related situations. For example, scientist Robert Koch, in his studies of anthrax, first established that a particular microorganism caused a particular disease, which led him to predict and identify the specific bacteria that causes cholera.

In this unit, students will have direct experience with cause and effect as they make objects move in different ways. Developing an understanding of forces lays the foundation for students to go beyond the observable and describe the connection between an effect and its cause. For example, students learn through hands-on activities that pushing an object causes the object to move, and then they deepen their understanding through reading about the mechanism that explains the cause–and–effect relationship—forces.

Engineering Design

Each unit in the Amplify Science: Elementary sequence focuses on one of four key practices of science or engineering: investigation, modeling, design, or argumentation. While all units include elements of all four practices, focusing more explicitly on one allows us to create multiple opportunities for students to experience that practice more fully. It also allows for the teacher to model that practice and support students' efforts so they can develop awareness and skill. Design units provide students with the opportunity to take on and understand a particular engineering problem, developing new knowledge that helps them to design, evaluate, and revise a solution.

What Is Engineering Design?

We live in designed societies. The cities and buildings that we live in, as well as the devices we use on a daily basis, are all the products of engineering. They have been designed using scientific knowledge, with an awareness of the criteria they are expected to meet related to function, cost, and aesthetics. Ironically, we are probably most aware of this design when it has been done poorly (e.g. when stairs in a building are spaced too widely or the buttons on a device are not intuitive). Design units are intended to invite students into the process of engineering design, and to help them recognize the designed parts of the world around them.

What Do Engineers Do?

Engineers define problems and design solutions. The connotations of *problem* and *solution* in engineering are different from the everyday meanings we are more likely to encounter. We often think of problems as negative, such as emotional problems. Or, we think of problems and their corresponding solutions as well-specified—with a single correct solution, as is often experienced in math classes. In engineering, a problem is an unmet want or need. Sometimes unmet needs do have negative repercussions if not addressed, such as the need for clean drinking water. Other times, a problem is a desire that is unsatisfied; in this case, its absence is less dire, such as wanting a more exciting roller coaster. Regardless, an unmet want or need is an engineering problem if knowledge of how the world works can be applied to create something that will address that want or need.

In engineering, problems are initially identified by an unmet want or need. Developing a solution to that problem, however, requires that the problem be further defined. What expectations do the people who will use the solution have for its performance? What constraints are imposed on the solution by the materials and money available or the circumstances in which the solution will be used? What are additional effects that a solution could have? In answering these questions, engineers define the criteria for success that the solution will have to address in order to solve the problem. The work required to better define and understand the nature of the problem distinguishes engineering problems from more straightforward or well-specified problems.

Once the problem is initially defined, engineers work to design a solution. Creating a solution is a design process because it involves intentionally applying scientific knowledge to create something functional, as well as considering the needs and expectations of the target users to make something useful. There is seldom a single "correct" solution to an engineering problem; rather, multiple possibilities could address the criteria for success in different ways.

Engineers iteratively test and revise solutions. A fundamental aspect of the engineering process is that it is iterative, which leads to the successive improvement of a solution. Engineers test aspects of their solutions through many phases of development—exploring and testing possible materials to choose the best options, creating and testing models or prototypes to inform the construction of the actual solution, and testing a version of the solution itself in realistic conditions. Often this process of iteration informs their understanding of the problem, as well as informs the design of the solution. Testing materials can identify the constraints those materials create. Testing prototypes or early solutions with users can clarify the criteria with which users evaluate a solution. Testing also provides the engineers with information about the performance of a solution compared to their goals and expectations, which allows them to make changes that will improve its performance.

Design Cycle

Scientists use multiple practices to figure out how the natural world works. They ask questions, plan and carry out investigations, analyze and interpret data, construct explanations, etc. While scientists work to figure out how the natural world works, engineers use design practices (and their knowledge of established science) to develop solutions to problems. Engineers' design practices include defining problems, identifying design goals, planning and constructing solutions to address those goals, testing solutions to see how well they meet those goals, and iterating on their previous designs to better meet their design goals.

While there are differences in solving problems between engineer's approach and the scientific approach, both approaches have much in common. There are eight practices outlined in the NGSS for scientific investigation and engineering design. Of these, six are shared between both approaches:

- Developing and Using Models
- Planning and Carrying out Investigations
- Analyzing and Interpreting Data
- Using Mathematics and Computational Thinking
- Engaging in an Argument from Evidence
- Obtaining, Evaluating, and Communicating Information

There are two NGSS practices in which the approaches of engineers and scientists differ:

- Asking Questions [Science] and Defining Problems [Engineering]
- Constructing Explanations [Science] and Designing Solutions [Engineering]

Scientists work to figure out how the natural world works, and then they explain it to others. Engineers define a problem based on something that people want or need; build any new knowledge they will need to solve the problem; and then design, test, and revise solutions to that problem.

Just as there is no single linear scientific method, there is no single design cycle. While science practices often follow a particular path (e.g., asking questions before investigating), just as often, the results of an investigation lead to new questions. This iterative process of wondering and investigating may repeat several times before a scientist is ready to move on to constructing explanations in an effort to answer an initial question.

Likewise, engineering practices often follow a particular path, or cycle, in which engineers first conduct research to better define a problem, identify design goals (or criteria), plan and make a design solution, and then test that solution to see if it meets the design goals. The cycle repeats as an engineer seeks to create improved design solutions. The simplest version of a design cycle can be as straightforward as Plan–Make–Test. Often, however, engineers will move back and forth between the different phases, learning more about ideas that are relevant to the problem, developing a better plan for a solution, refining a solution they have created, or testing an aspect of a solution. The Amplify Science curriculum program introduces students to a design cycle of Learn–Plan–Make–Test.

In this unit, students work toward an understanding of the design cycle by first focusing on a simplified cycle of Learn–Make in the early chapters. In the first four chapters, students learn about forces and motion, and then use their learning to inform changes to their designs. In the last two chapters, Plan and Test are introduced, and then students use this expanded design cycle to create final versions of their designs.

- **Learn.** In the Learn phase, sometimes considered a research phase, engineers work to understand and define the problem they are trying to solve, better understand the needs of users, establish design goals (or design criteria), identify constraints, and learn relevant information. In the *Pushes and Pulls* unit, students engage in the Learn phase as they explore making tennis balls move in small groups, as they obtain information from images and text, and when they discuss their observations from the Rugball game. Exploring with the tennis balls contains various elements of the design cycle, such as planning and testing ideas. For simplicity, however, we describe these smaller preparatory cycles as all part of the Learn phase.
- **Plan.** This is when engineers use what they have learned through their research to plan a solution they hope will meet their design goals. Students engage in the Plan phase in Chapter 5, when they plan and draw diagrams of their Box Models (their prototype pinball machines) that can reach every design goal. In previous chapters, students also engaged in the Plan phase, without it being introduced or formalized, by using what they designed in their Box Models to inform the construction of the Class Pinball Machine. They plan solutions throughout the unit.
- **Make.** Depending on what's being designed, the Make phase (actually making the proposed solution) can vary in length. If problems are encountered during the Make phase, it is not uncommon for engineers to return to the Plan phase before moving on to the Test phase. Students engage in the Make phase each time they work with their Box Models.

- **Test.** Engineers test the solutions they make. Testing can involve something as simple as a taste test or something as involved as trying out a new design over the course of a year. Students test their solutions during Chapter 5, when they use a checklist to assess whether they have met their design goals. In previous chapters, students also engaged in the Test phase, without it being introduced for formalized, when they worked with their Box Models to meet smaller design goals. They moved the Box Model components around, testing their solutions against the design criteria and making changes as necessary.

As engineers cycle back through the phases of the design cycle, they may return to the Plan (or research) phase to develop additional background knowledge. They may also return to the Learn phase after evaluating results from the Test phase, learning from and using those results to revise their solutions.

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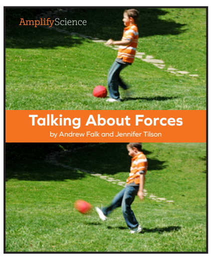
Grade K: *Pushes and Pulls: Designing a Pinball Machine*

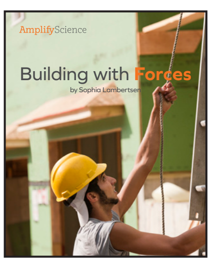
Book Summaries

Here are short descriptions of the five full-color *Pushes and Pulls* student science books.



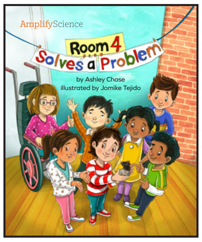
Talking About Forces

Talking About Forces introduces students to several foundational concepts for the unit, including the idea that forces make things move. The book also introduces key scientific language for explaining what is happening when a force makes something move. Students learn that scientists and engineers say that when one thing is making another thing move, it is exerting a force on it. Relatable examples and photographs help students connect the concepts they are learning in the unit with what they see in the world around them. The book helps students view the world through a scientific lens and see how forces are being exerted all the time. *Talking About Forces* is used as a Read-Aloud book at the beginning of the unit to introduce the content and help students connect movement with the forces that cause it to happen.



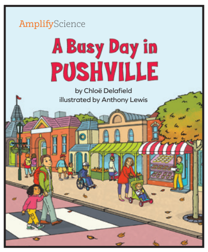
Building with Forces

Building with Forces features construction workers who are building houses and stores. The book highlights forces being exerted in different directions: up, down, to the left, to the right, toward, and away. Students learn that construction workers must exert forces in the correct directions so everything ends up where it belongs. *Building with Forces* is used as a Shared Reading midway through the unit to help students visualize how forces exerted in different directions make things move in those directions. Construction photographs and simple text engage students in learning this foundational concept.



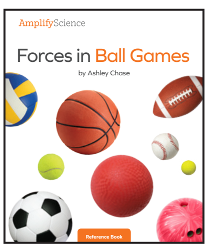
Room 4 Solves a Problem

In Room 4 Solves a Problem, a group of kindergartners encounter a problem: Their class pet, Ratty, needs to get more exercise. Students jump into action, designing solutions that use pushes and pulls to alleviate Ratty's problem. They test out several solutions and then refine and improve their solutions until they have designed the perfect push-and-pull exercises for Ratty. *Room 4 Solves a Problem* is a Read-Aloud book that models the design process that students are using to create their pinball machines in the unit.



A Busy Day in Pushville

A Busy Day in Pushville is written from the perspective of a young girl who sees people using pushes and pulls in their jobs and activities all around town as she goes to the library with her dad. After she and her dad come home, she also notices pushes and pulls as they paint and draw, make dinner, and more. Students are encouraged to look for evidence of forces throughout the book. *A Busy Day in Pushville* is used as a Shared Reading at the end of the unit to help students synthesize information and explain all the different kinds of forces they have learned about in the unit. The book provides a bridge to an activity in which students search for evidence of forces in and around the school.



Forces in Ball Games

Forces in Ball Games is the reference book for this unit. It explores the types of forces in many different ball games, both familiar and new. Showing how forces are exerted in the context of games helps solidify the connection between the physics content that students are learning and the pinball machines they are creating. The reference book is used during a Partner Read and in Read-Alouds throughout the unit and offers an opportunity to look for changes of direction, stopping and starting motion, and strong and gentle forces.

Grade K: *Pushes and Pulls: Designing a Pinball Machine*

Managing the Unit

Teaching a science class that integrates hands-on activities and technology with reading, writing, and discussion can be challenging—especially the first time. However, if you have taught activity-based science before, you'll find managing this unit easier than units comprised of a higher percentage of firsthand activities. Lessons involving reading and writing take less preparation and management—and they are rarely messy! There are also some basic strategies and practices you can employ that will help make things go smoothly.

Before You Present the Lessons

Read about the Amplify Science curriculum approach. You can find important information about aspects of our approach in our program overview documents. Reading these in advance will help the lessons make more sense. Also provided are several unit overview documents that explain our approach within the context of a particular unit. You can find these with the Unit Overview in the digital instructional guide.

Read the instructional guide. Be sure to read the instructional guide for each lesson before you present that lesson. If you can, reading through an entire chapter will give you the best sense of where the unit is moving. However, if you aren't able to do that, rely on the chapter summaries provided in the Unit Overview about what students do and learn in each chapter.

Read the student books. Read each student book before you present it to students. This should take just a few minutes and will enable you to better anticipate your students' reading needs and to prepare for using the big book in Read-Aloud or Shared Reading activities.

Get to know your materials kit. The materials kit includes nearly everything you will need to present this unit. Items not included in the unit's materials kit are general supplies that are used across many different units (e.g., trays, dish tubs), which can be purchased in the Amplify Science starter kit. There are also some materials that you will need to supply, including typical school supplies (e.g., chart paper, markers, rulers) and, for some units, food items (things that are perishable and, therefore, cannot be included in the kit). Familiarize yourself with the kit materials, including the printed materials, before beginning the unit. Refer to the Materials and Preparation at a Glance document (with the Unit Overview in the instructional guide) for a complete list of the materials provided in the kit, materials that are teacher provided and/or provided in the starter kit, and the lessons that will require extra preparation time.

Set aside time to prepare before each lesson. Before presenting each lesson, review the Materials and Preparation sections in the instructional guide. The Materials section lists the items that will be used in the lesson and how many of each will be needed for the class, pairs of students, and each student. The Preparation section details specific instructions for preparing before the day of the lesson and immediately before the lesson.

Plan ahead. Reading the Preparation at a Glance section of the Materials and Preparation at a Glance document (with the Unit Overview in the instructional guide) will give you a sense of the lessons in which extra preparation time is needed. Roughly half the lessons will require only 15 minutes or less of advance preparation. There are some lessons that will require more preparation time, especially the first time you teach them. By planning ahead, you will not only be able to make preparation more efficient, you will also be able to consolidate and schedule the preparation tasks at times that are most convenient for you.

Involve adult volunteers in helping to prepare class materials. Learning to ask for adult assistance can be an important time-saving strategy. The Preparation at a Glance section of the Materials and Preparation at a Glance document (with the Unit Overview in the instructional guide) indicates which lessons have self-contained tasks that can be handed off to adult volunteers. Some of these tasks can be sent home with an adult to be completed in the evenings or on weekends.

Purchase or make copies of the Investigation Notebook ahead of time. You can purchase a printed Investigation Notebook for each student, or you can print out the PDF of the Investigation Notebook (in Digital Resources in Lesson 1.4 and in Unit Overview) and copy and bind one notebook for each student. Surprisingly, purchasing printed Investigation Notebooks can be cheaper than paying to duplicate enough copies for your class. You can also ask for adult volunteers who are willing to make copies of the Investigation Notebook at their workplaces. Many workplaces have sufficiently large copy volumes that they are happy to make such an in-kind contribution.

Make a plan for how students will move between individual and partner work. Most lessons involve students working individually as well as working with and discussing with a partner. If you already have table groups, this will be relatively easy. If students sit at individual desks, decide how they will work with and talk to partners and how they will reorient their seats to work individually again.

Make a plan for how you will project. Many lessons involve projecting images, prompts, and notebook pages for students. At times, you will also project and model different activities. Whenever possible, it is recommended that you project these class references by using an interactive whiteboard, a document camera, projecting onto a whiteboard, or whatever system you typically use that can allow you to also record responses. **Note:** If you are not able to see the instructional guide while you are projecting, you may want to have two different digital devices, if possible—one connected to a projector and one for referring to the instructional guide. Alternatively, in each lesson, a PDF of all projections for that lesson is provided (in Digital Resources)—you can open this in a separate tab and toggle between the instructional guide and the projections (as well as the PDF of the Investigation Notebook).

Make paper posters, charts, and tables ahead of time. This unit relies on the use of chart paper to create visual records of data and ideas in lessons when what's recorded needs to be revisited in later lessons. You will find models of completed class posters/charts in Digital Resources (in the appropriate lessons). These can be printed out for easy reference as you prepare for each lesson. Detailed instructions for creating these on chart paper are provided in the Preparation section for each lesson in the instructional guide. If you have limited wall space in your classroom, you might consider creating class charts and leaving the sheets of chart paper intact on the pad, placing the pad on a chart stand, and flipping through the individual charts when needed.

Get to know the structure and features of the digital instructional guide. See Amplify Academy for more resources to help familiarize yourself with how to use the digital instructional guide.

While You Present the Lessons

Set up separate work areas and discussion areas. You will find that the lessons go more smoothly if you set up your classroom with a work area that is separate from a discussion area. Sitting in a circle on a carpet makes a wonderful discussion area. This can be where you start and end each lesson. Although students will be working individually or with partners, a table for every four students might make the best work area, as long as you define each pair's workspace.

Set up distribution stations for materials. The most efficient way to distribute trays of materials or other materials that need to be distributed during an activity is to set up distribution stations from which you or students can obtain materials as needed. If space in your classroom is limited, you may have room for only one station. If you have more space, we recommend setting up two or three distribution stations to relieve student traffic at each station.

Prepare and set out materials on trays. The cafeteria-style trays provided in the starter kit are wonderful management devices for the materials you will use in the inquiry science lessons in the unit. For each hands-on investigation activity, set out as many trays of materials as needed for each pair. This can be especially efficient if the materials will be needed for more than one lesson, since this allows you to leave the materials set up. Economize space by stacking the trays in a corner of your classroom. Often, trays can be stacked with the materials still on them.

Provide instructions before distributing materials. Don't try to talk to the class when students have materials in front of them. If you do, keep your message very brief. The temptation for students to handle the materials when they are in front of them is overwhelming. You will find that waiting to distribute materials until after everyone knows what they are to do will make a huge difference. Likewise, collecting materials before you have a reflection discussion is recommended.

Establish routines. Set up consistent routines for getting students' attention, distributing materials, collecting materials, and cleaning up. Students will come to expect these routines, and cleaning up will be more efficient. You can assign cleanup duties to students as needed. If you already have rotating classroom jobs, integrate cleanup during science class into your existing system.

Invite adult volunteers or older students to help during the lessons. Having an extra pair of hands (or more) during the firsthand science lessons can help a great deal with class and materials management. Often, teachers ask older students to come in to help during the science lessons—everyone enjoys and benefits from these interactions. An extra person to help individual students with reading and writing during the literacy lessons is also helpful, although not necessary.

After You Present the Lessons

Keep the materials kit organized. Each time you present the unit, it will get easier and easier. It's worth the effort to keep your kit tidy and organized so the next time you use it, it will be in good shape. Putting sticky notes inside the kit to remind you of items that need to be restocked will save you time when you use the kit again.

Write notes about lessons learned and things to improve next time. Use the My Notes feature in the instructional guide to record your reflections on how you might want to do things differently the next time you teach the unit. You can record notes about the unit as well as about individual lessons.

Grade K: *Pushes and Pulls: Designing a Pinball Machine*

Materials and Preparation at a Glance

Materials at a Glance

This is a complete list of all the materials needed to present the entire *Pushes and Pulls: Designing a Pinball Machine* unit twice. For reordering information, call Amplify: 1 (800) 823-1969.

Note: Check and follow your district's safety regulations pertaining to the use of safety goggles for students participating in hands-on science activities.

Items Provided in the *Pushes and Pulls* Kit

Quantity	Description	Used in lesson
93	baggies, plastic, quart size with zip*	1.3, 1.4, 2.3, 3.2, 3.4, 4.3, 5.1, 5.2, 5.3
1	ball, foam, 6"	1.2, 2.1, 2.2, 3.1, 3.3, 3.4, 4.1, 4.2
73	balls, table-tennis*	1.4, 2.3, 3.2, 3.4, 4.3, 5.1, 5.2, 5.3
73	binder clips, large*	1.3, 1.4, 2.3, 3.2, 3.4, 4.3, 5.1, 5.2, 5.3
1	cardboard box, 12" x 24" x 2"	1.2, 1.5, 2.3, 3.5, 4.3, 5.3
73	cardboard box, 11" x 17" x 2", with slots*	1.4, 2.3, 3.2, 3.4, 4.3, 5.1, 5.2, 5.3
16	dowels, 2" long	1.5, 4.3
18	marbles, flat	1.3
2 rolls	masking tape*	throughout
18	nuts, large, metal	1.3
1	peg board, 1' x 2'	1.2, 1.5, 2.3, 3.5, 4.3, 5.3
81	rubber bands (large)*	1.4, 1.5, 2.3, 3.2, 3.4, 4.3, 5.1, 5.2, 5.3
160	rubber bands (medium)*	4.3, 5.1, 5.2, 5.3
24	rubber bands (small)*	4.3, 5.3

*consumable item

Items Provided in the *Pushes and Pulls* Kit (continued)

Quantity	Description	Used in lesson
73	shoelaces, 12"*	1.3, 2.1, 2.3, 3.2, 3.4, 4.3, 5.1, 5.2, 5.3
19	tennis balls	2.1, 3.1, 3.3, 3.4, 4.1
200	wooden sticks (tongue depressors)*	1.3, 4.3, 5.1, 5.2, 5.3
	Print materials	
1	*Pushes and Pulls: Designing a Pinball Machine* Investigation Notebook	throughout
1 set	Explanation Language Frames Cards: Set 1 (7 cards)	1.3
1 set	Explanation Language Frames Cards: Set 2 (4 cards)	2.2
1 set	Explanation Language Frames Cards: Set 3 (8 cards)	3.2
1 set	Explanation Language Frames Cards: Set 4 (2 cards)	3.4
1 set	Explanation Language Frames Cards: Set 5 (4 cards)	4.2
1 set	Forces Cards: Large (8 cards)	2.2
18 sets	Forces Cards: Small (8 cards)	2.2
18 sets	Forces Cards Set: Headers (2 cards)	2.2
1 set	Pinball Machine Design Goals Chart: Diagrams 1–9 (9 cards)	1.5, 2.3, 3.5, 4.3
1 set	What We Know About Forces Chart: Icons 1–6 (5 cards)	1.3, 2.2, 3.2, 4.2
73	Box Model Mat 1: Long/Short*	2.3
73	Box Model Mat 2: Left/Right*	3.2
73	Box Model Mat 3: Targets*	3.4
	Print materials for the classroom wall	
6	Chapter Questions	throughout
1	Unit Question	throughout
2	section headers: Key Concepts, Vocabulary	throughout
9	vocabulary cards	throughout

*consumable item

Items Provided in the *Pushes and Pulls* Kit (continued)

Quantity	Description	Used in lesson
	Student books	
18 + 1 big book	*A Busy Day in Pushville*	6.1, 6.2
18 + 1 big book	*Building with Forces*	3.1, 3.2
18 + 1 big book	*Forces in Ball Games*	2.2, 3.5, 4.1, 4.2
18 + 1 big book	*Room 4 Solves a Problem*	5.1, 5.2
18 + 1 big book	*Talking About Forces*	1.2, 1.5

Amplify Science Elementary also offers a starter kit available for purchase. This kit includes general science materials needed to conduct most hands-on activities and experiments for all units in the Amplify Science Elementary curriculum program. Items in the starter kit can fulfill some of the teacher-provided kit materials needed for each unit.

Items Provided in the Starter Kit

Quantity	Description
2	dish tubs, medium size
2	gloves, latex free, boxes (100 pairs/box)*
36	goggles, safety, child size
18	lenses, hand, plastic
1	sticky notes, yellow, 3" x 3", pack (12 pads/pack, 100 notes/pad)*
2	tape, masking, rolls*
19	trays, plastic

*consumable item

Items to Be Provided by the Teacher

Quantity (1 class)	Description	Used in lesson
18	cardboard tube (optional)	1.3
18	clothespins (optional)	1.3
18	cotton balls (optional)	1.3
36	crayon, black	1.3 (optional), 2.3, 3.4, 4.3, 5.1
36	crayon, blue	1.3 (optional), 4.3, 5.1

*consumable item
**provided in starter kit

Items to Be Provided by the Teacher (continued)

Quantity (1 class)	Description	Used in lesson
36	crayon, brown	1.3 (optional), 4.3, 5.1
36	crayon, orange	1.3 (optional), 4.3, 5.1
36	crayon, red	3.4, 5.1
39	cubes, small interlocking plastic or wooden	1.2, 1.3
18	dice (optional)	1.3
18	erasers (optional)	1.3
10	magnets, whiteboard (optional)	1.2, 1.5
1	marker, wide tip, black	throughout
1	marker, wide tip, brown	4.3, 5.1
1	marker, wide tip, orange	1.4, 2.3, 3.4, 4.3, 5.1
1	marker, wide tip, red	3.4, 5.1
1	marker, wide tip, blue	4.3, 5.1
18	math manipulative (such as small interlocking plastic cubes,counting bears, or small blocks)	1.3
1 box	paper clips*	throughout
18 sheets	paper towel or tissue*	1.3
18	paper, any size, crumpled into a ball (optional)*	1.3
1 pad	paper, chart*	1.1, 1.3, 1.4, 1.5, 2.3, 3.5, 4.3
57 sheets	paper, regular or construction, 8.5" x 11"	3.3, 5.1, 5.2
18	pipe cleaners, any color	1.3
100	sentence strips	throughout
2 pads	sticky notes, square, 3x3* **	3.5, 5.2
1	whiteboard or pocket chart	1.3, 1.5, 2.4
18	wooden blocks (optional)	1.3

*consumable item
**provided in starter kit

Preparation at a Glance

The information provided here is an overview of the amount of time we estimate it will take you to prepare the materials for each lesson of the *Pushes and Pulls* unit. This does not include the time you will need to spend reading the instructional guide, previewing the student activities and student books, or reviewing students' work.

The Materials and Preparation sections in the Lesson Brief of each lesson (in the instructional guide) include detailed preparation steps to be completed before the day of each lesson as well as steps to be done immediately before each lesson. This preparation time is summarized in the tables on the following pages to assist in your planning. We suggest actually calendaring your lessons, taking particular note of the lessons that require more preparation time.

Asterisks in the tables denote that preparations for those lessons have self-contained tasks that are easily handed off to adult volunteers. Doing so can reduce or eliminate prep time in those instances. Plan ahead by inviting adult volunteers to come in a few days before these lessons. **Note:** Amount of time listed for each lesson is the total estimated amount of preparation time needed and not just the time for any self-contained task(s) listed.

Chapter 1

Lesson	Title	Preparation time frame (in minutes)
1.1	Pre-Unit Assessment: Students' Initial Explanations	30–60: Preview unit overview documents. Create all class charts and key concepts for unit.* (Alternatively, you can create class charts and key concepts before each lesson in which they are needed.) 30–60 (optional): Make copies of the Investigation Notebook rather than purchase additional copies.*
1.2	Talking About Forces	15: Build the Class Pinball Machine.*
1.3	Forces Happen Between Two Objects	20: Assemble bags of Forces Investigation materials.*
1.4	We Are Engineers	60: Build Box Models.* Assemble bags of Box Model materials.* Locate orange and black crayons.*
1.5	Writing About Forces	5

Preparation at a Glance (continued)

Chapter 2

Lesson	Title	Preparation time frame (in minutes)
2.1	Exploring Shorter and Longer Distances	5
2.2	Strong and Gentle Forces	10
2.3	Designing a New Launcher	10: Add shoelaces to bags of Box Model materials.* Locate orange and black crayons.*

Chapter 3

Lesson	Title	Preparation time frame (in minutes)
3.1	Movement in Different Directions	5
3.2	Building with Forces	10
3.3	Direction and Strength	10
3.4	Targets in the Box Model	10: Locate orange, black, and red crayons.*
3.5	Applying Strength and Direction	5

Chapter 4

Lesson	Title	Preparation time frame (in minutes)
4.1	Changing Directions	10
4.2	Forces Change an Object's Direction	10
4.3	Flippers and Bumpers	20: Add wooden sticks and rubber bands to bags of Box Model materials.* Locate orange, black, brown, and blue crayons.*

Preparation at a Glance (continued)

Chapter 5

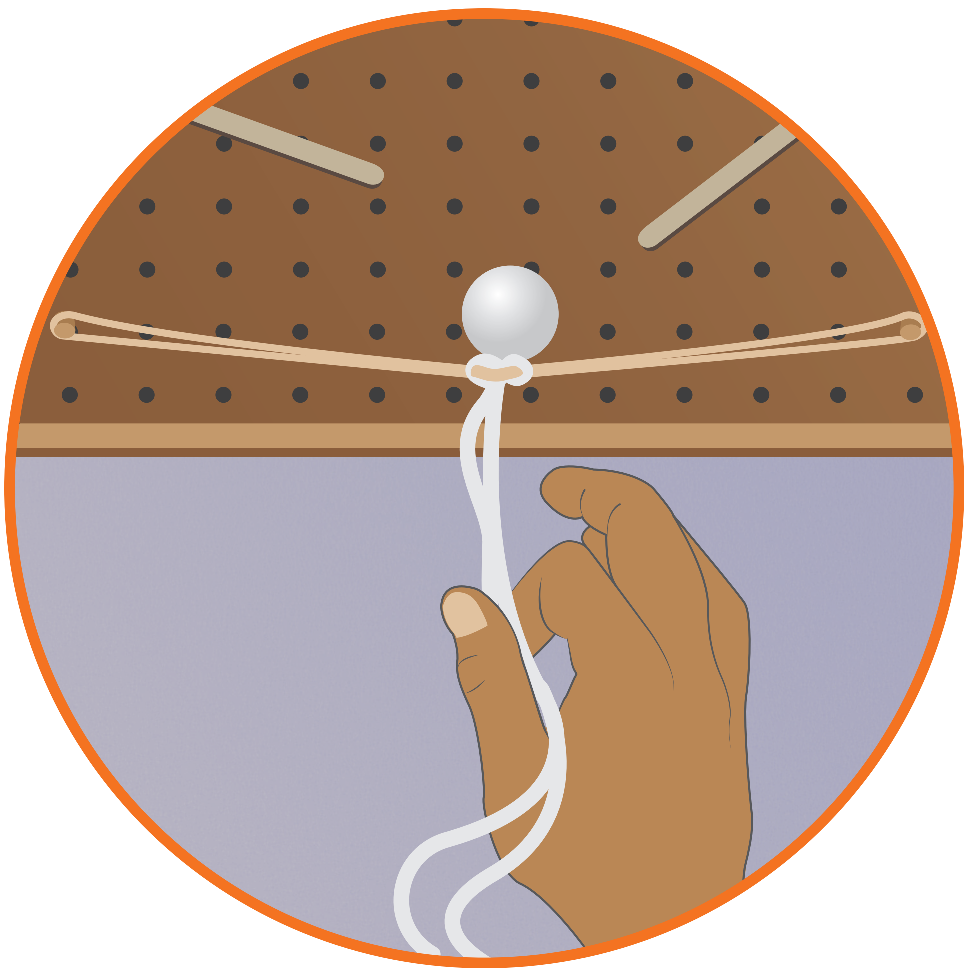
Lesson	Title	Preparation time frame (in minutes)
5.1	Room 4 Solves a Problem	5: Locate orange, black, brown, blue, and red crayons.*
5.2	Testing and Improving Our Box Models	45: Assemble mini-books.*
5.3	Showcasing Our Box Models	5

Chapter 6

Lesson	Title	Preparation time frame (in minutes)
6.1	Searching for Forces	5
6.2	A Busy Day in Pushville	20
6.3	End-of-Unit Assessment: Students' Culminating Explanations	5

Amplify Science

Pushes and Pulls:
Designing a Pinball Machine



Investigation Notebook

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Developed by the Learning Design Group at the University of California, Berkeley's Lawrence Hall of Science.

Amplify Science Elementary is based on the *Seeds of Science/Roots of Reading*® approach, which is a collaboration between a science team led by Jacqueline Barber and a literacy team led by P. David Pearson.

www.scienceandliteracy.org

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Pushes and Pulls: Designing a Pinball Machine
ISBN: 978-1-943228-86-7

Table of Contents

Safety Guidelines for Science Investigations

1. **Follow instructions.** Listen carefully to your teacher's instructions. Ask questions if you do not know what to do.

2. **Do not taste things.** No tasting anything or putting it near your mouth unless your teacher says it is safe to do so.

3. **Smell substances like a chemist.** When you smell a substance, do not put your nose near it. Instead, gently move the air from above the substance to your nose. This is how chemists smell substances.

4. **Protect your eyes.** Wear safety goggles if something wet could splash into your eyes, if powder or dust might get in your eyes, or if something sharp could fly into your eyes.

5. **Protect your hands.** Wear gloves if you are working with materials or chemicals that could irritate your skin.

6. **Keep your hands away from your face.** Do not touch your face, mouth, ears, eyes, or nose while working with chemicals, plants, or animals.

7. **Tell your teacher if you have allergies.** This will keep you safe and comfortable during science class.

8. **Be calm and careful.** Move carefully and slowly around the classroom. Save your outdoor behavior for recess.

Safety Guidelines for Science Investigations (continued)

9. **Report all spills, accidents, and injuries to your teacher.** Tell your teacher if something spills, if there is an accident, or if someone gets injured.

10. **Avoid anything that could cause a burn.** Allow your teacher to work with hot water or hot equipment.

11. **Wash your hands after class.** Make sure to wash your hands thoroughly with soap and water after handling plants, animals, or science materials.

3

Name: ______________________________ Date: ____________

Box Model Diagram: Drawing the Launcher

Directions:

1. Draw the launcher in orange.

2. Draw the ball.

3. Draw how the ball moved.

Name: ______________________________ Date: ______________

Box Model Diagram:
Drawing the Launcher (continued)

Name: ________________________________ Date: ______________

Box Model Diagram: Drawing the Ball Moving a Short Distance

Directions:

1. Draw the launcher in orange.

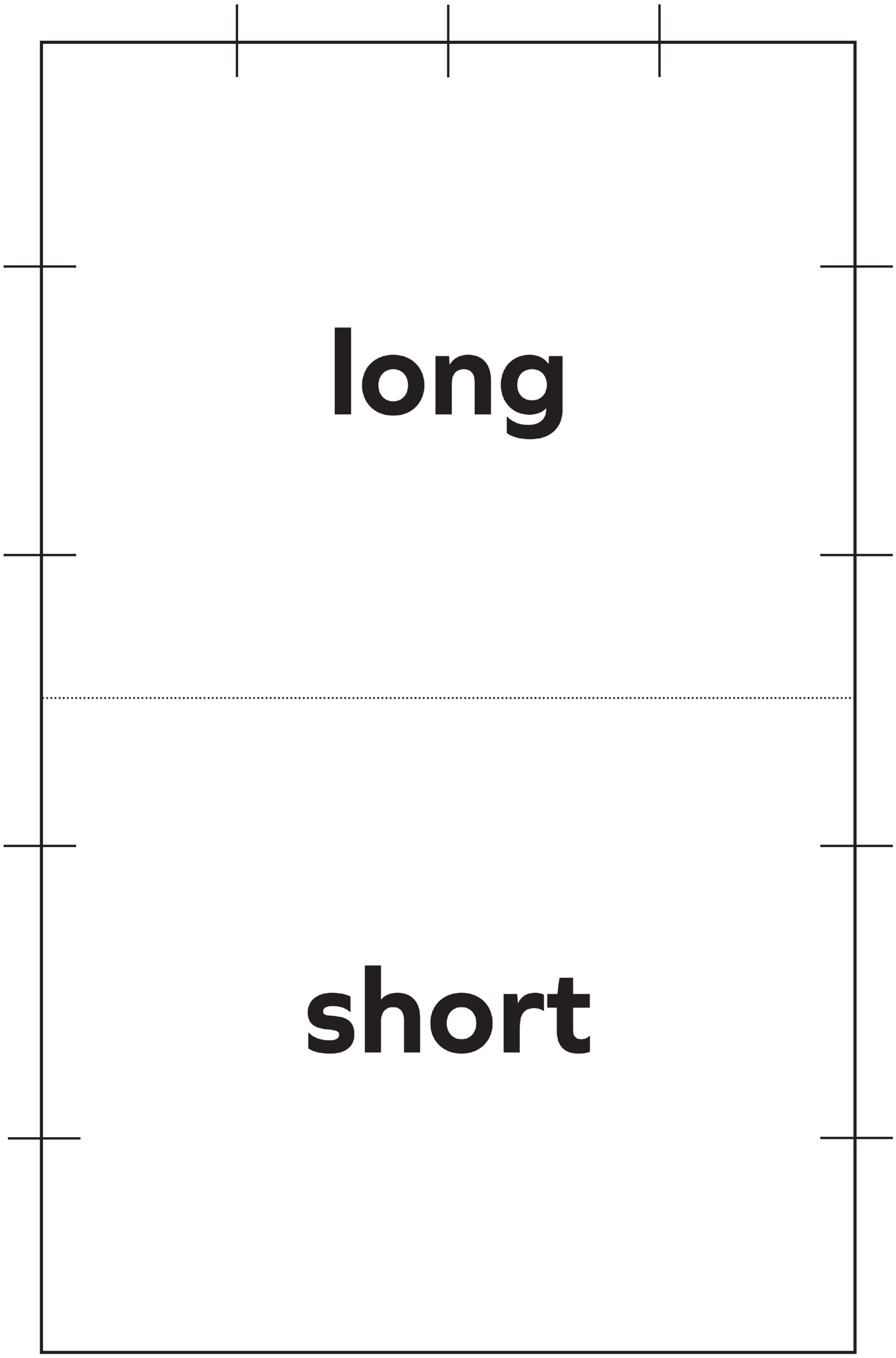
2. Draw the shoelace in black.

3. Draw the ball.

4. Draw how the ball moved.

Name: ______________________________ Date: ______________

Box Model Diagram: Drawing the Ball Moving a Short Distance (continued)



Name: ______________________________ Date: ______________

Box Model Diagram: Drawing the Ball Moving a Long Distance

Directions:

1. Draw the launcher in orange.

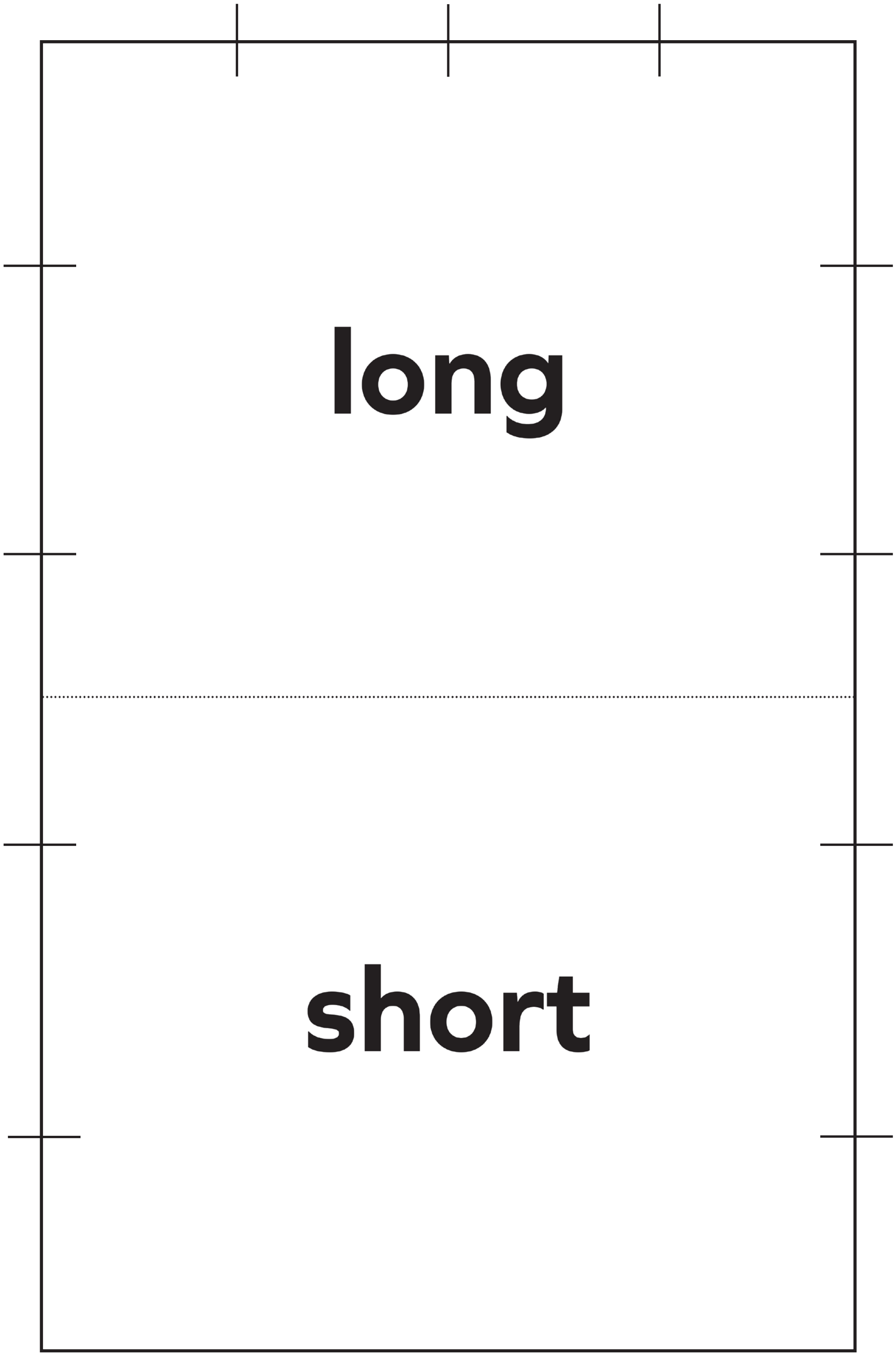
2. Draw the shoelace in black.

3. Draw the ball.

4. Draw how the ball moved.

Name: ______________________________ Date: ______________

Box Model Diagram:
Drawing the Ball Moving a Long Distance (continued)



Name: ______________________________ Date: ______________

Box Model Diagram: Drawing the Ball Moving to Targets

Directions:

1. Choose a target. Color it red.

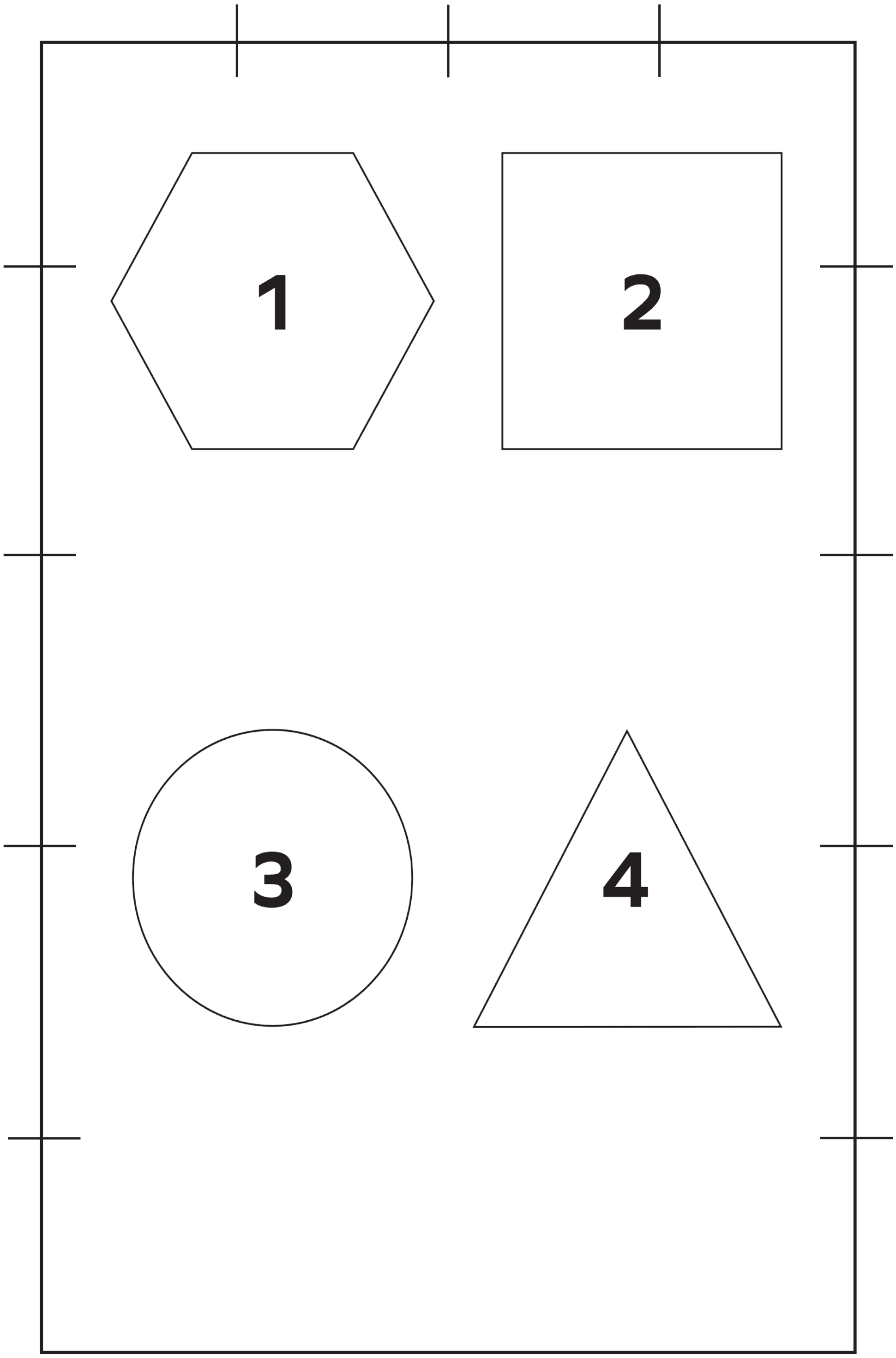
2. Draw the launcher in orange.

3. Draw the shoelace in black.

4. Draw the ball and how it moved to your target.

Name: ______________________________ Date: ______________

Box Model Diagram:
Drawing the Ball Moving to Targets (continued)



Name: ______________________________ Date: ______________

Box Model Diagram: Drawing a Bumper

Directions:

1. Draw the launcher in orange.

2. Draw the shoelace in black.

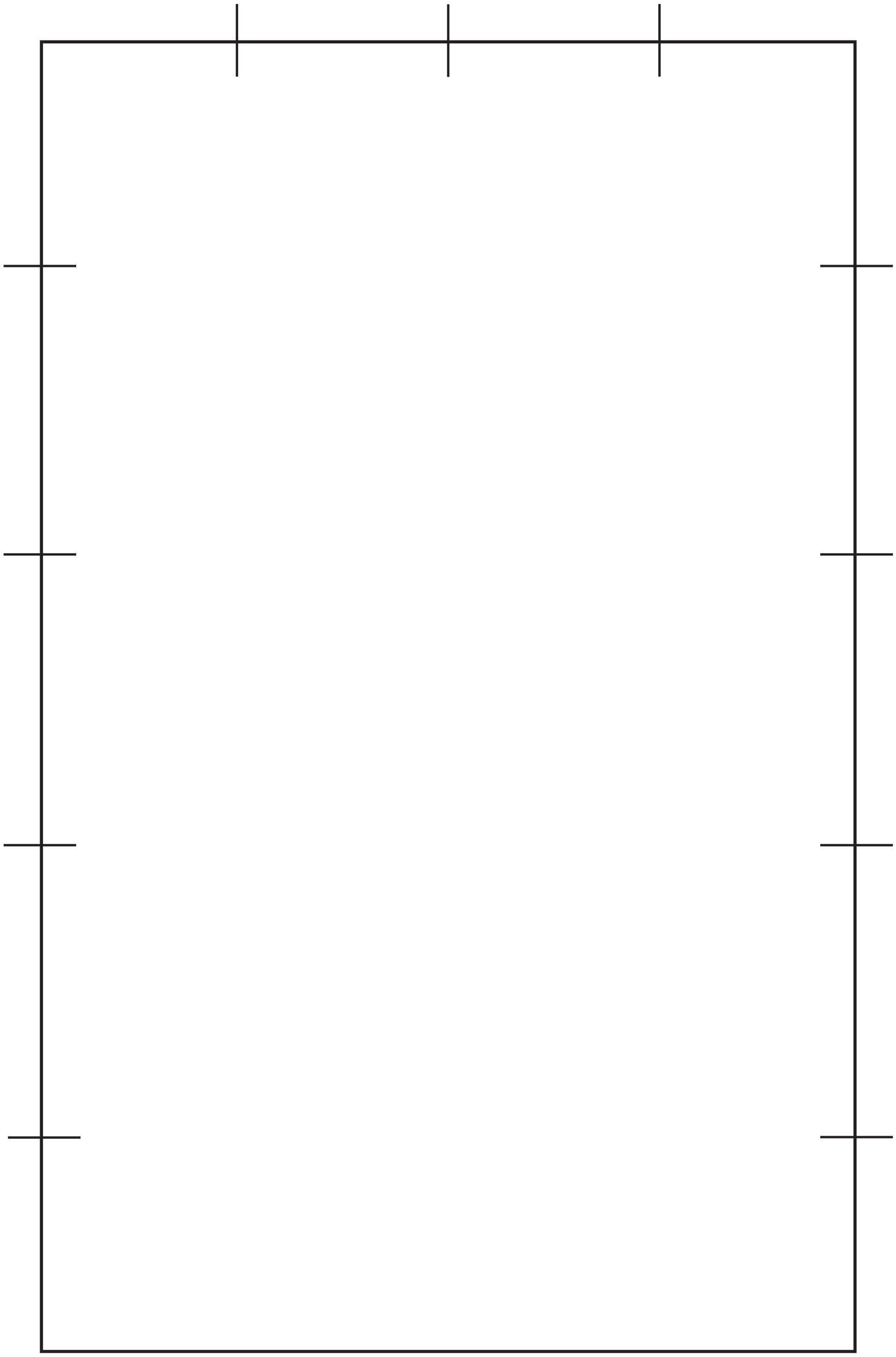
3. Draw the bumper in brown.

4. Draw the ball and how it moved to your target.

5. Make an X at any place you think a force was exerted on the ball.

Name: ______________________ Date: ______________

Box Model Diagram: Drawing a Bumper (continued)



Name: ______________________________ Date: ____________

Box Model Diagram: Drawing Flippers

Directions:

1. Draw the launcher in orange.

2. Draw the shoelace in black.

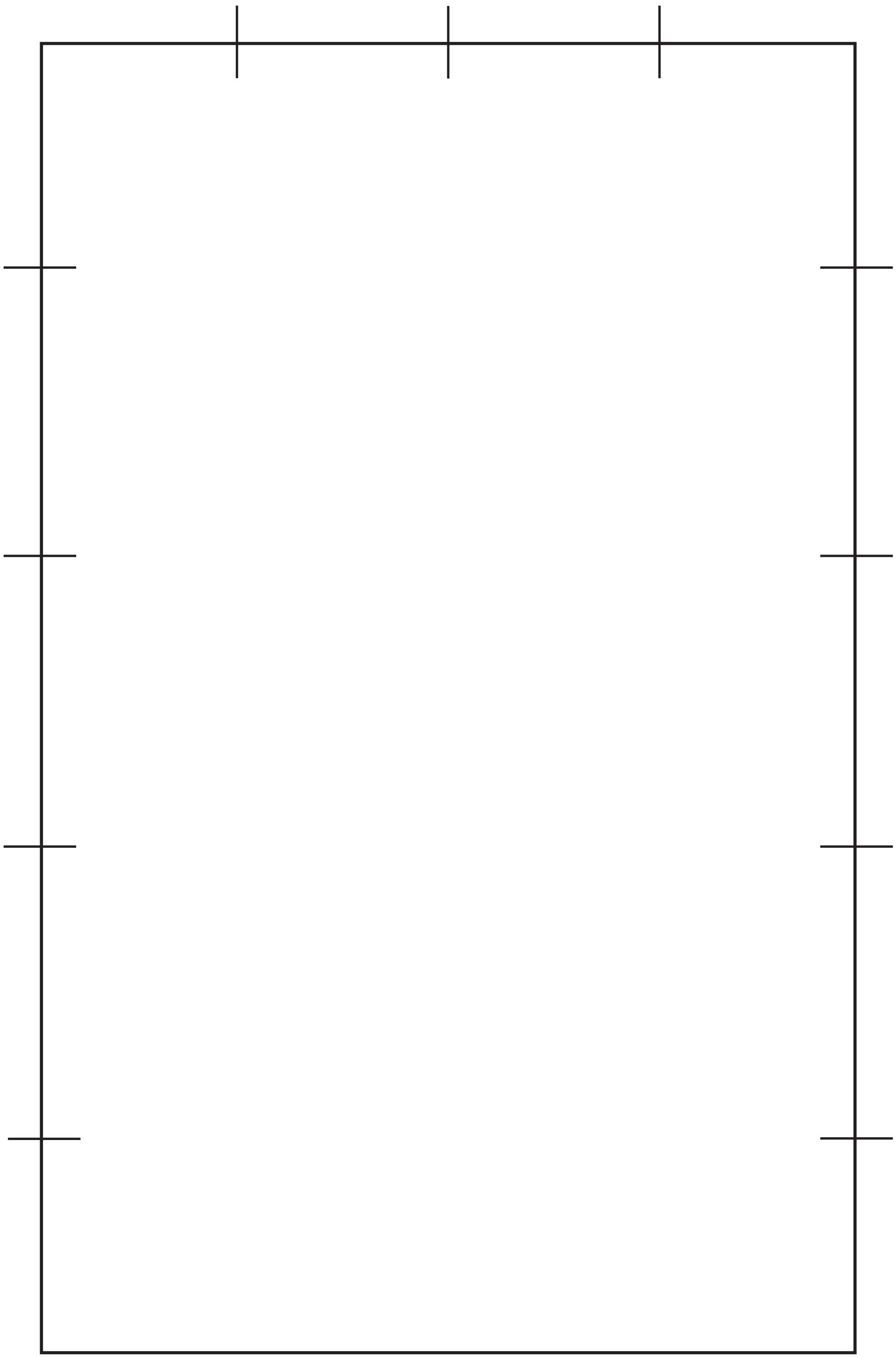
3. Draw the flippers in blue.

4. Draw the ball and how it moved to your target.

5. Make an X at any place you think a force was exerted on the ball.

Name: ______________________ Date: ____________

Box Model Diagram: Drawing Flippers (continued)



Name: ______________________________ Date: ____________

Box Model Diagram: Planning Our Box Models

Directions:

1. Draw the launcher in orange.

2. Draw the shoelace in black.

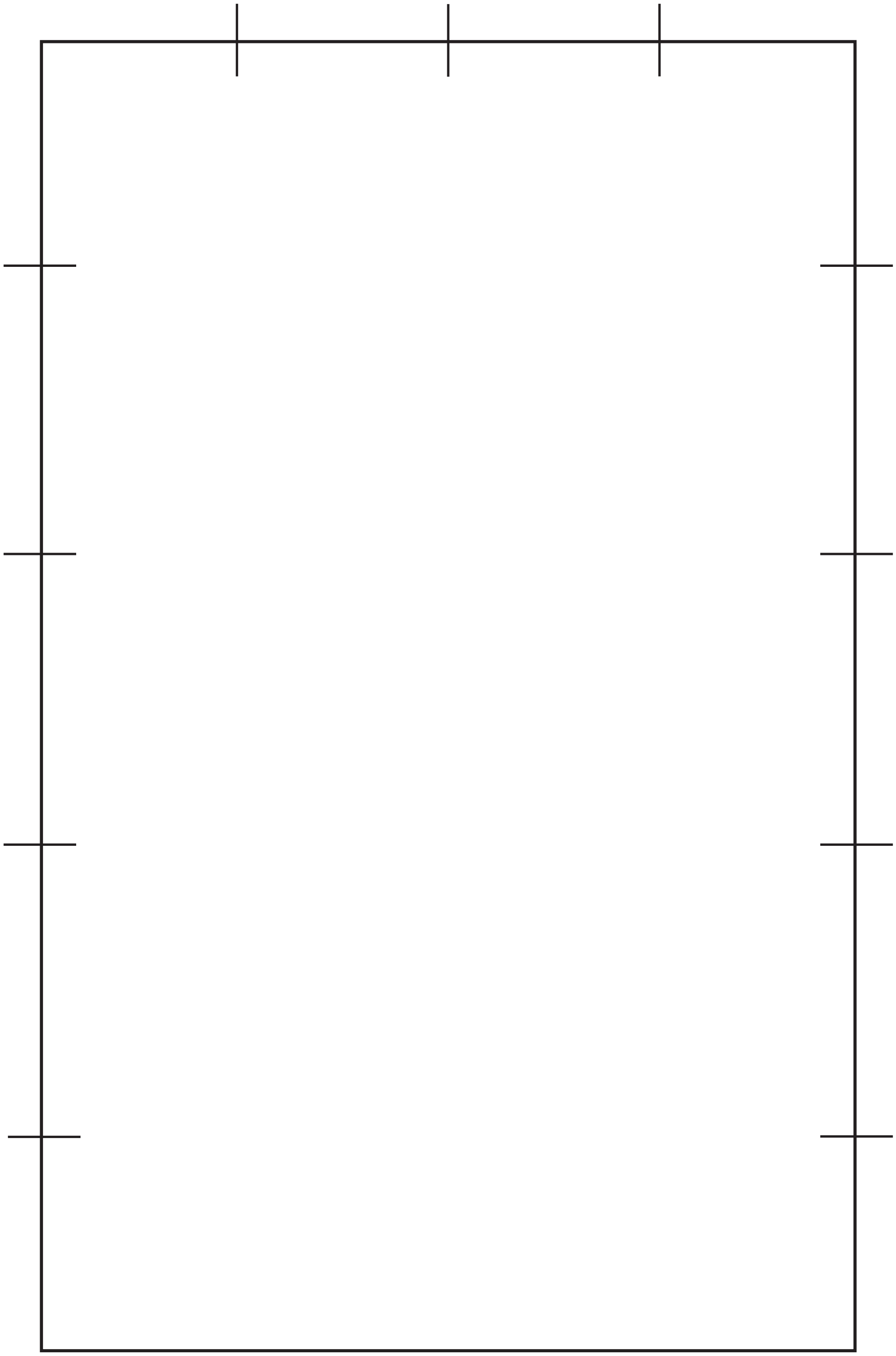
3. Draw the target in red.

4. Draw the flippers in blue.

5. Draw the bumpers in brown.

Name: ______________________ Date: ______________

Box Model Diagram: Planning Our Box Models (continued)



Name: ______________________________ Date: ____________

School Forces Tour

Directions:

1. In each box, draw evidence of a force you observe.
2. On the line below each box, label where you found the force.

Name: ______________________________ Date: ______________

You can use this page to write notes or create drawings.

Glossary

design to try to make something new that people want or need
diseñar intentar hacer algo nuevo que las personas quieren o necesitan

direction the way something is facing or moving, such as left, right, toward you, or away from you
dirección la forma en que algo se enfrenta o se mueve, como izquierda, derecha, hacia usted, o lejos de usted

distance how far it is between two things
distancia la medida entre dos cosas

exert to cause a force to act on an object
ejercer hacer que una fuerza afecte a un objeto

engineer a person who makes something in order to solve a problem
ingeniero una persona que hace algo para solucionar un problema

force a push or a pull
fuerza un empuje o un jalón

Glossary (continued)

object a thing that can be seen or touched
objeto una cosa que se puede ver o tocar

solution something that helps people do what they want or need to do
solución algo que ayuda a las personas a hacer lo que quieren o necesitan hacer

visualize to make a picture in your mind
visualizar hacer una imagen en tu mente

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Stephanie L. Strachan
Jade Sharify Talbot

Amplify:

Irene Chan
Shira Kronzon
Charvi Magdaong
Thomas Maher
Matt Reed
Steven Zavari

Your Investigation Notebook

Scientists use notebooks to keep track of their investigations. They record things they learn from other scientists. Sometimes they draw or make diagrams. They record ideas and information they want to remember.

Your Investigation Notebook is a place for you to keep track of:

- investigations you do in class.
- what you learn from reading science books.
- your questions, predictions, and observations.
- your explanations and the evidence you find to support those explanations.
- your ideas!

THE LAWRENCE HALL OF SCIENCE
UNIVERSITY OF CALIFORNIA, BERKELEY

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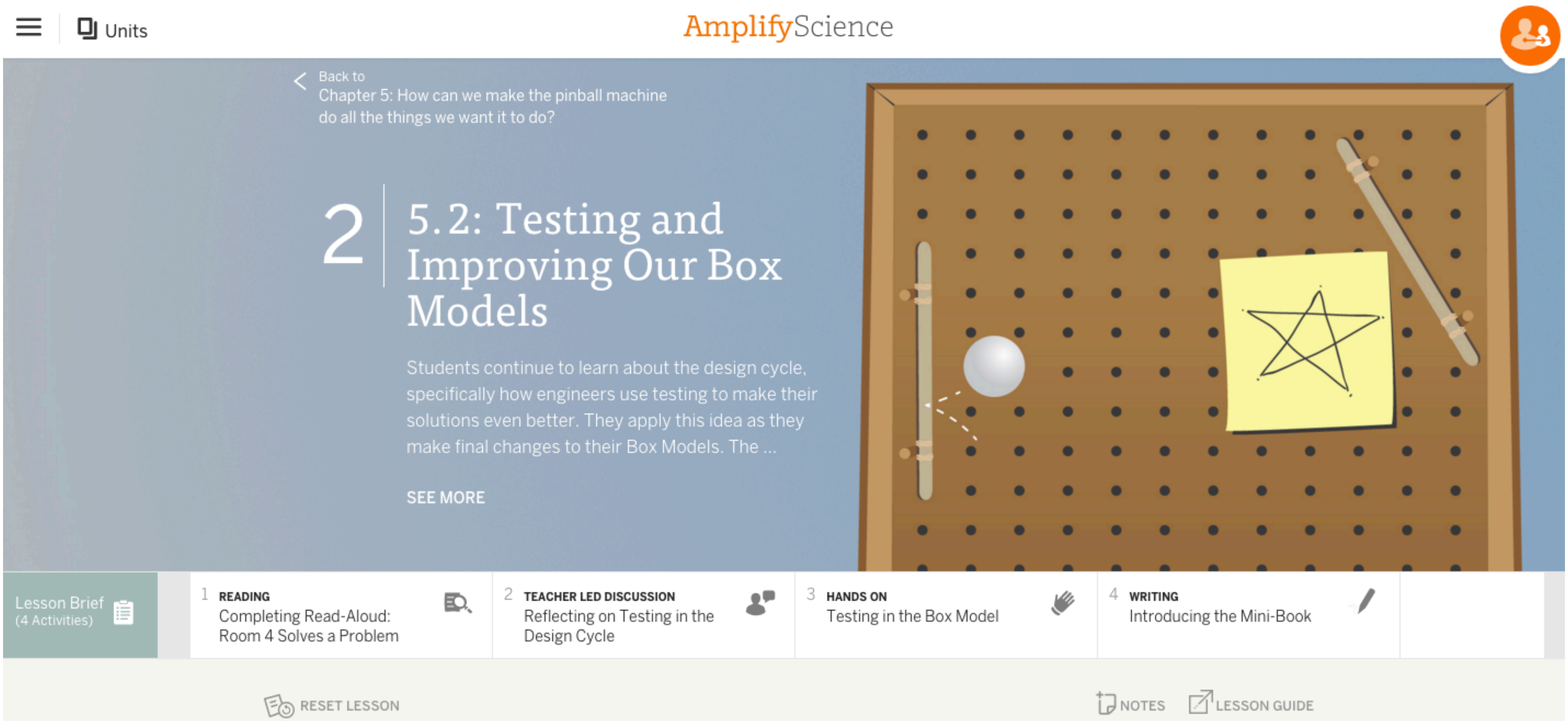
APPENDIX H


Units
AmplifyScience
Back to
Chapter 5: How can we make the pinball machine do all the things we want it to do?
2
5.2: Testing and Improving Our Box Models
Students continue to learn about the design cycle, specifically how engineers use testing to make their solutions even better. They apply this idea as they make final changes to their Box Models. The ...
SEE MORE
Lesson Brief (4 Activities)
1 READING Completing Read-Aloud: Room 4 Solves a Problem
2 TEACHER LED DISCUSSION Reflecting on Testing in the Design Cycle
3 HANDS ON Testing in the Box Model
4 WRITING Introducing the Mini-Book
RESET LESSON
NOTES
LESSON GUIDE

Unit 6A | Pushes and Pulls

Chapter 5: How can we make the pinball machine do all the things we want it to do?

2 | 5.2: Testing and Improving Our Box Models

Lesson Overview

Students continue to learn about the design cycle, specifically how engineers use testing to make their solutions even better. They apply this idea as they make final changes to their Box Models. The lesson begins with a Read-Aloud of the second half of the *Room 4 Solves a Problem* book, which illustrates how students solve a problem by testing and making, iteratively, as part of the design cycle. Students use what they learn in the story to finish the What Engineers Do chart by adding the "Test" phase, noting how engineers engage in various phases of the design cycle over and over. Students continue to work on their Box Models, testing their solutions to see if the model works as expected and making changes as necessary. The lesson closes with students beginning to write a mini-book about how their Box Model works. The purpose of this lesson is to continue toward completing the Box Models and to provide students with a deeper experience of working with all phases of the design cycle.

Students learn:

- Engineers test their solutions to problems, and make changes based on what happens.

Lesson at a Glance:

1: Completing Read-Aloud: *Room 4 Solves a Problem* (15 min)
Students listen to a Read-Aloud of the second half of *Room 4 Solves a Problem*, which focuses on the process of students' testing and improving their solutions.

2: Reflecting on Testing in the Design Cycle (5 min)
Students review the ideas in the book and classify what students in Room 4 did as they worked as engineers. Students learn how testing and making over and over again is a key part of engineers' work in the design cycle.

3: Testing in the Box Model (15 min)
Students use a ball to test all the features they planned and made in their Box Model, making changes along the way. They make improvements so that their solution meets each goal on the Pinball Machine Design Goals chart. This activity includes an On-the-Fly Assessment of how students evaluate their solutions based on specific design goals.

4: Introducing the Mini-Book (10 min)
Students are guided through writing the first two sections of the *How to Play Pinball with Forces* mini-book, which will serve as a how-to guide for anyone who wants to play pinball using their Box Model. Writing this book provides students an opportunity to communicate in writing what they have learned about forces from their work in the Box Models.

We'd love to hear from you! Submit your feedback here.

Materials

For the Classroom Wall

- Pinball Machine Design Goals chart
- What Engineers Do chart
- What We Know About Forces chart

For the Class

- demonstration Box Model
- demonstration Box Model materials bag
- *Room 4 Solves a Problem* big book
- *How to Play Pinball with Forces* Mini-Book copymaster
- Pinball Machine Design Goals Checklist copymaster
- 1 sheet of blank printer paper*
- marker*
- masking tape

For Each Student

- Box Model (with materials from previous lesson still attached)
- Box Model materials bag
- Pinball Machine Design Goals Checklist student sheet
- 1 assembled mini-book
- 1 sticky note, 3" x 3"*
- *Pushes and Pulls* Investigation Notebook (pages 16–17)

*teacher provided

Preparation

Before the Day of the Lesson

1. **Locate the following item (in your *Pushes and Pulls* kit):**
    - *Room 4 Solves a Problem* big book
2. **Print out and assemble the mini-books.** Print out the *How to Play Pinball with Forces* Mini-Book copymaster (PDF in Digital Resources). Make enough copies for each student to get one assembled mini-book, plus one copy for you to use as a class demonstration in Lesson 5.3. (Note: The copymaster consists of two pages.) To assemble each mini-book, follow these directions: Fold each sheet in half along the shorter dotted line. Make sure the printed side faces out. Fold each sheet in half again along the visible dotted line. Assemble pages: Have the front cover with the title on the outside and insert the other folded sheet in order of page numbers. Staple each book along the fold on the left-hand side.
3. **Make copies of the Pinball Machine Design Goals Checklist.** Print out the Pinball Machine Design Goals Checklist copymaster (in Digital Resources) and make enough copies so each student can get one copy.

4. **Prepare a new diagram for your demonstration Box Model.** In Activity 3, you will use your demonstration Box Model and a new diagram, featuring a drawing of an incorrect launcher with the shoelace and rubber band reversed from their normal positions. The launcher is intentionally drawn in a location where it will not work so that you can model making changes during the activity. Print a blank copy of page 17, Box Model Diagram: Planning Our Box Models, from the Investigation Notebook to use for your diagram frame. Complete the diagram, using the appropriate colors, according to the Sample Incorrect Box Model Diagram reference (in Digital Resources). Use the diagram to set up all the elements of your Box Model (except the target, which you will place during the activity).

5. **Check student progress in Box Models.** Students will have a second work session in their Box Models to make final changes and then test their solutions against the Pinball Machine Design Goals Checklist. Check their general progress making changes according to their diagrams. If some students are very behind, consider giving them some time to catch up with the rest of the class before the lesson. Refer to the Completed Box Model (in Digital Resources) for one possible completed Box Model layout.

6. **Decide how you will manage Box Model materials as student test their solutions.** During the Box Model work session, students will finish making changes in their Box Models, and then test them out. Students will be ready to test at different times. Plan if you want them to come to you to check their diagrams before you give them their table-tennis ball or if you want to leave a container of table-tennis balls available so students can grab one when they feel they are ready.

7. **Set out the Box Models.** Students will return to their workstations to work on their Box Models in Activity 3.

8. **Preview the additions to the What Engineers Do chart.** In Activity 2, you will post one sheet of printer paper on the left side of the What Engineers Do chart, and then write additions to the chart on it during the lesson. The word "Test" will be written in the center of the paper and then you will fill in arrows above and below the word. See What Engineers Do Chart: Completed (PDF in Digital Resources) for guidance.

9. **Preview the second half of the *Room 4 Solves a Problem* book.** You will finish reading the second half of this book in Activity 1. This portion of the text emphasizes how the students in Room 4 made solutions to their problem, and how they made their solutions better based on what they saw happen.

10. **Follow up on Critical Juncture Assessment 4 (from Lesson 4.3).** If you need to follow up with additional instruction for your class or a group of students, review the Assessment note in the Teacher Support tab in Activity 3 (Augmenting Instruction: Differentiating in Response to Critical Juncture Assessment 4).

11. **Prepare for the On-the-Fly Assessment.** Included in Activity 3 is an On-the-Fly Assessment. The assessment provides an opportunity to informally assess students evaluating their solutions based on specific design goals. Select the hummingbird icon on the menu bar and then select the ON-THE-FLY ASSESSMENT for details about what to look for and how you can use the information to maximize learning by all students.

Immediately Before the Lesson

1. **Have on hand the following items.**

   - demonstration Box Model
   - prepared sample incorrect diagram
   - *Room 4 Solves a Problem* big book
   - assembled *How to Play Pinball with Forces* mini-books
   - Pinball Machine Design Goals Checklists
   - marker
   - masking tape

- *Pushes and Pulls* Investigation Notebooks

At the End of the Day

1. **Collect Box Models and Pinball Machine Design Goals Checklists.** These will be used again in the next lesson.

Projections: Lesson 5.2

What Engineers Do Chart: Completed

Completed Box Model

Sample Incorrect Box Model Diagram

How to Play Pinball with Forces Mini-Book copymaster

Pinball Machine Design Goals Checklist copymaster

- design
- engineer
- solution

Differentiation

Embedded Supports for Diverse Learners

Modeling the design cycle. You will model how to test a solution with the Box Model that does not work and then make a change to improve your solution. Modeling making revisions and the attitude around making the revision is important. Students should understand that taking the time to make changes and improve their Box Models is part of the design process and is not a sign that a solution is bad. This understanding can help students when engaging in the practices of engineers.

Modeling how to write a mini-book. During the modeling process, you will highlight key features of the *How to Play Pinball with Forces* mini-book and show students how to complete the sentences that go along with the diagrams. This will help students become familiar with the content of the mini-book and help them understand how they will write words to complete the sentences. This also prepares students to add their own diagrams to their mini-books in the next lesson.

Potential Challenges in This Lesson

Redesigning. This chapter is different than the others; instead of adding more components to their Box Models, students make changes to their models. Kindergarten students can be quite invested and take pride in the products they have created. They may feel frustrated when asked to make changes to their models, which they think work perfectly well. Support students in understanding that part of the design process is to make changes to create an even better solution and that working in this way reinforces the practices of engineers.

Specific Differentiation Strategies for English Learners

Prepare students for the design-cycle discussion. As students finish learning the phases of the design cycle, make sure they are comfortable with the words they used in the previous lesson: *learn*, *make*, and *plan*. In this lesson, students add the word *test* to the What Engineers Do chart. Students may be familiar with the word test from academic tests in the context of school, but they may not be familiar with the use of the word in this context—to try something out to see if it works or not.

Cognates. Many words in English and Spanish are cognates—words that are similar in spelling and meaning in both languages. By explicitly pointing out the existence of cognates to native Spanish speakers (and other English learners with Latin-based native languages), you can assist these students in reading and comprehending science books and content. The Spanish cognates that will be helpful for your students in this lesson are: *design/el diseño*, *engineer/ingeniero*, and *solution/la solución*.

Specific Differentiation Strategies for Students Who Need More Support

Mini-book support. For students who need additional support with the mini-book, it may help to read the sentences ahead of time for students who need more time to consider their responses before the whole-class activity. This support could take the form of working in a small group, sounding out words together, or referring to any classroom resources to support students' writing.

Specific Differentiation Strategies for Students Who Need More Challenge

Continue designing solutions for Ratty. If you have students who began to plan solutions for Ratty in Lesson 5.1, this lesson provides a good opportunity for them to make and test the solutions they planned. This extension activity is designed to go along with what students in the book (*Room 4 Solves a Problem*) are doing.

Next Generation Science Standards (NGSS)

NGSS Practices

- **Practice 2:** Developing and Using Models
- **Practice 3:** Planning and Carrying Out Investigations
- **Practice 4:** Analyzing and Interpreting Data
- **Practice 6:** Constructing Explanations and Designing Solutions
- **Practice 8:** Obtaining, Evaluating, and Communicating Information

NGSS Disciplinary Core Ideas

- **PS2.A: Forces and Motion:**
    - Pushes and pulls can have different strengths and directions. (K-PS2-1),(K-PS2-2)
- **PS2.A: Forces and Motion:**
    - Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it. (K-PS2-1),(K-PS2-2)
- **PS2.B: Types of Interactions:**
    - When objects touch or collide, they push on one another and can change motion. (K-PS2-1)
- **PS3.C Relationship Between Energy and Forces:**
    - A bigger push or pull makes things speed up or slow down more quickly. (secondary) (K-PS3.C)
- **ETS1.B: Developing Possible Solutions:**
    - Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. (K-2-ETS1-2)
- **ETS1.C: Optimizing the Design Solution:**
    - Because there is always more than one possible solution to a problem, it is useful to compare and test designs. (K-2-ETS1-

3)

NGSS Crosscutting Concepts

- Cause and Effect
- Scale, Proportion, and Quantity
- Structure and Function
- Stability and Change

Common Core State Standards for English Language Arts (CCSS-ELA)

- **CCSS.ELA-LITERACY.RI.K.3:** With prompting and support, describe the connection between two individuals, events, ideas, or pieces of information in a text.
- **CCSS.ELA-LITERACY.RI.K.4:** With prompting and support, ask and answer questions about unknown words in a text.
- **CCSS.ELA-LITERACY.W.K.7:** Participate in shared research and writing projects (e.g., explore a number of books by a favorite author and express opinions about them).
- **CCSS.ELA-LITERACY.SL.K.1:** Participate in collaborative conversations with diverse partners about kindergarten topics and texts with peers and adults in small and larger groups.
- **CCSS.ELA-LITERACY.SL.K.2:** Confirm understanding of a text read aloud or information presented orally or through other media by asking and answering questions about key details and requesting clarification if something is not understood.
- **CCSS.ELA-LITERACY.L.K.6:** Use words and phrases acquired through conversations, reading and being read to, and responding to texts.

Common Core State Standards for Mathematics (CCSS-Math)

CCSS-Math Practices

- **CCSS.MATH.PRACTICE.MP1:** Make sense of problems and persevere in solving them.
- **CCSS.MATH.PRACTICE.MP2:** Reason abstractly and quantitatively.
- **CCSS.MATH.PRACTICE.MP4:** Model with mathematics.
- **CCSS.MATH.PRACTICE.MP6:** Attend to precision.

CCSS-Math Content

- **CCSS.MATH.CONTENT.K.MD.1:** Describe measurable attributes of objects, such as length or weight. Describe several measurable attributes of a single object.
- **CCSS.MATH.CONTENT.K.MD.2:** Directly compare two objects with a measurable attribute in common, to see which object has “more of”/“less of” the attribute, and describe the difference. For example, directly compare the heights of two children and describe one child as taller/shorter.
- **CCSS.MATH.CONTENT.K.G.1:** Describe objects in the environment using names of shapes, and describe the relative positions of these objects using terms such as above, below, beside, in front of, behind, and next to.

Unplugged?

Lesson at a Glance

1.	**COMPLETING READ-ALOUD: ROOM 4 SOLVES A PROBLEM** Students participate in a Read-Aloud of *Room 4 Solves a Problem* to see how the class continues to design solutions to their problem. (15 min.)
2.	**REFLECTING ON TESTING IN THE DESIGN CYCLE** Students add “Test” to complete the the What Engineers Do chart. They refer to both the book and their own work. (5 min.)
3.	**TESTING IN THE BOX MODEL** Students use their diagrams to finish making and testing their improved Box Models. (15 min.)
4.	**INTRODUCING THE MINI-BOOK** The teacher leads students in a guided writing of the first two pages of the *How to Play Pinball with Forces* mini-book. (10 min.)

READING

1. Completing Read-Aloud: Room 4 Solves a Problem

Students participate in a Read-Aloud of *Room 4 Solves a Problem* to see how the class continues to design solutions to their problem. (15 min.)

CARD 1

INSTRUCTIONAL GUIDE

1. Show the cover of *Room 4 Solves a Problem*. Remind students they read the first half of the book in the last lesson.

2. Refer to the What Engineers Do chart to discuss the problem. Point to the chart as you remind students that, in the book, the students in Room 4 worked as engineers to solve a problem about their class pet.

What problem were the student engineers trying to solve?
[Their rat needed more exercise.]

3. Point to *Learn*. Turn to the images on pages 6–7.

What did the students learn from their teacher about exercises for rats?
[Rats cannot do exercises like jumping jacks or lifting weights.]

4. Point to *Plan*. Turn to the images on pages 8–10.

How did the students plan a solution to their problem? What did they do?
[Went home to think of ideas. Drew pictures and diagrams. Shared their ideas.]

5. Point to *Make*.

Yesterday, you predicted that the students in Room 4 would make their solutions next. Today, we will read about what types of solutions they made and how they worked.

6. Set the purpose for reading.

As we read the second part of the book today, keep thinking about how the children in the book are engineers. Listen for times when the students in Room 4 make their solutions do all the things they want them to do.

7. Read pages 11–12 aloud. Pause on page 12 to model visualizing.

I can visualize how Ratty is pushing a big ball that does not fit. It keeps falling off when Ratty pushes it.

8. Pause briefly after page 13 to visualize. Remind students to make a picture in their head about what Omar just did.

What did Omar have to do to make his idea work?
[Use a smaller ball. Change his plan]

That is right—Omar had to make changes to make his solution work.

Let's read and find out if Kai needs to make changes to her solution after testing it.

9. Continue reading through page 17. Remind students to visualize Kai's idea as you read.

Did Kai's first solution work?
[No.]

So, what did Kai do after she tested her first solution?
[She made changes. She got new ideas. She used different peas.]

After she tested her second solution, did it work?
[Yes.]

How is that like what happened to Omar?
[It did not work the first time. They tried it out two times.]

I see a pattern! Students tested and made changes. Then, their solutions worked much better to give Ratty the exercise he needs.

10. Continue to read through the end of the book.

TEACHER LED DISCUSSION

2. Reflecting on Testing in the Design Cycle

Students add "Test" to complete the the What Engineers Do chart. They refer to both the book and their own work. (5 min.)

CARD 1

INSTRUCTIONAL GUIDE

1. Refer to the What Engineers Do chart. As you lead a discussion about how the students in Room 4 followed the design cycle, point to the *Learn* and *Plan* icons on the chart.

The students in Room 4 worked as engineers to try to solve their problem. The students in Room 4 learned and planned to figure out a solution to their problem.

2. Point to *Make* on the chart. Refer to illustrations in the book, if needed.

What did the student engineers in Room 4 make?
[A track for the ball, a holder for Ratty's food, and a maze.]

3. Discuss what students did after they made their solution.

The students made many things to get Ratty to exercise. How did they know if it worked?
[They tried it out. They tested it.]

Yes, they tested it. Once they tested it, they could make the changes.

4. Post the blank sheet of paper over the left side of the chart and add "Test" to the cycle. Also add one smaller arrow connecting *Make* and *Test.*

Test means to try something out and find out what happens.

5. Discuss testing in the Box Models.

Think about when you were making a solution in your Box Models. Did you ever try something out and have it not work the way you wanted it to?

Call on one or two students to share an example of making an unsuccessful change in their Box Model. If students do not volunteer, highlight times you made changes to your demonstration Box Model or to the Class Pinball Machine and they did not work.

Sometimes, the first thing that an engineer makes and tests does not work how they would like it to.

6. Point out that engineers make changes after testing. Indicate *Make* and *Test* on the What Engineers Do chart.

The students in Room 4 made changes once they tested the solution they had planned. They made and tested over again, more than once.

An important part of being an engineer is testing and making changes to a solution to improve it. Engineers often do different parts of the cycle over again.

7. Make note of the book's ending.

What happened once Room 4 had designed several ways for Ratty to exercise? Was that the end to their work as engineers?
[No! Then they needed to solve the problem of where the new rat could sleep.]

Add the arrow from *Test* to *Learn.*

That is another thing that happens a lot with engineering—once you solve one problem, there is often a new problem to solve. Sometimes, designing a solution to one problem means that you learn about a new one.

HANDS ON

3. Testing in the Box Model

Students use their diagrams to finish making and testing their improved Box Models. (15 min.)

CARD 1

INSTRUCTIONAL GUIDE

1. Augment instruction. If you are adjusting instruction in this activity in response to Critical Juncture Assessment 4 (from Lesson 4.3), review the Assessment note in the Teacher Support tab (Augmenting Instruction: Differentiating in Response to Critical Juncture Assessment 4) for suggested modifications to this activity.

2. Hold up your demonstration Box Model and the new diagram you prepared.

Last night, I got so excited about our work as engineers that I made a new diagram to plan changes in my own Box Model. Then I made the changes I planned to my Box Model.

Show how you followed your plan on the diagram to set up your Box Model.

3. Point out your drawing on the target. Indicate the simple shape you have drawn on the sticky note. Let students know they will be allowed to choose what to draw on their target.

4. Distribute Pinball Machine Design Goals Checklists. Explain that students will get their own sheet with the pinball machine design goals. Review the diagrams on the checklist, pointing out how they are just like the ones on the completed Pinball Machine Design Goals chart. Ask students what each diagram represents.

Remind students that engineers work together—if they forget what a diagram means, they can ask students around them for help.

5. Model using the checklist and not reaching the goal. Use your Box Model and explain that you will show students how to use the checklist.

Engineers test their solutions to see if they will work.

Try to launch the pinball using the launcher you have prepared with the shoelace instead of the rubber band.

Did my solution work to make the pinball start to move?
[No.]

This might happen to you when you test your Box Model, too. What do you think I should do when a part of my solution does not work?
[Make changes].

6. Move your launcher to reach the goal. Have students suggest how you should change your launcher, and then place the rubber band in the first set of slits at the bottom of the Box Model. Try again to launch the ball.

Did it work?
[Yes!]

I tested it again, and it worked this time. Can I check it off my checklist now?
[Yes!]

Check off the first checklist item: *Make the ball start to move.*

7. Explain purpose of testing in the Box Model. Explain that today students will get a pinball and be able to test everything they planned in their diagrams and made in their Box Models during the last lesson. Let students know that they will use their Pinball Machine Design Goals Checklist and check off, one by one, what their Box Model can do.

Remember, the first time I tried to make the ball start to move, it did not work. I could not check it off in my checklist, but then I changed my solution and now it works. So, I can check it off. You will test and make, test and make, trying to reach each design goal.

8. Set expectations for safe use of materials. Remind students of the safety guidelines you have established regarding the use of rubber bands and the expectations regarding use of the table-tennis ball.

9. Distribute checklists, table-tennis balls, and Investigation Notebooks. For students who need to continue setting up their Box Models according to their plans on pages 16–17 of their notebooks, establish a system in which they can finish their setups and then ask for a pinball to start testing.

10. Students begin testing Box Models. Remind students that as they test their Box Models, they can make changes if necessary.

11. On-the-Fly Assessment: Students work on Box Models. Circulate and monitor progress, supporting students as needed. Highlight the work students are doing, including how students are using the Pinball Machine Design Goals Checklist, testing machines, and making necessary design changes.

12. Gather students' attention. Time permitting, allow one or two students to share by identifying a change they made in their Box Model after testing.

13. Collect Box Models and table-tennis balls.

WRITING

4. Introducing the Mini-Book

The teacher leads students in a guided writing of the first two pages of the *How to Play Pinball with Forces* mini-book. (10 min.)

CARD 1

INSTRUCTIONAL GUIDE

1. Summarize students' work on their Box Models.

We have created a working model of a pinball machine! I know you will have many people who want to play this with you. You are the experts in how they work.

2. Revisit the What Engineers Do chart. Point to the phrase at the bottom of the chart and read it aloud.

Share to communicate and explain your ideas.

One way we have shared to communicate our ideas as we have worked as pinball engineers has been to write together.

3. Introduce the *How to Play Pinball with Forces* mini-book. Display a copy of the mini-book.

You are the engineer who designed your model and now you will be the expert in helping people know how to play. To do this, we will write a book to let players know how to use the pinball machine.

In this book, you will write about what you have learned about how to move a pinball with forces. Once you are finished, you can take this book home and read it to others.

4. Distribute the mini-books. Give students a minute or two to look through the book. Let them know they will keep their Box Models nearby to help them write.

5. Project Mini-Book: Front Cover. Point to and read aloud the title.

How to Play Pinball with Forces.

Encourage students to point and read along with you in their own mini-books. Have them write their name in the space on the front cover.

6. Project Mini-Book: Pages 1–2. Have students turn to pages 1–2 in their mini-books. Point to and read aloud the sentence on this page.

Exert a strong __ to make the pinball move a long distance.

What word would an engineer use to finish this sentence?
[Force.]

Model how to use the *force* vocabulary card or the What We Know About Forces chart for support in writing the word “force” in the blank on this page. Have students write the word “force” in the blank on this page in their mini-books. Point to and read aloud the completed sentence with students.

Exert a strong force to make the pinball move a long distance.

7. Discuss page 2. Invite students to describe what they see on page 2 in their mini-books. If it is not mentioned by students, point out how the ball is shown moving from the launcher, all the way to the top, which is a long distance.

The diagram on this page will show someone who reads the book what we just described in writing: *Exert a strong force to make the pinball move a long distance.*

Point out the features of the diagram.

The diagram on this page helps anyone who reads your book understand how moving the ball a long distance works. It shows a mat with short and long distances, the ball, and an arrow to show the movement.

8. Project Mini-Book: Pages 3–4. Have students turn to pages 3–4 in their mini-books. Point to and read aloud the sentence on this page.

__ a force to the left to make the pinball move to the left.

What word would an engineer use to finish this sentence?
[Exert.]

Model how to use the *exert* vocabulary card for support in writing the word “exert” in the blank on this page. Have students write the word “exert” in the blank on this page in their mini-books. Point to and read aloud the completed sentence with students.

Exert a force to the left to make the pinball move to the left.

9. Discuss page 4. Invite students to describe what they see on page 4 in their mini-books.

In this diagram here, I see the ball moving to the left. So, this diagram shows someone who reads the book what we just described in writing. It shows what it looks like when the ball moves to the left.

What parts does the diagram have to show the ball moving to the left?
[The mat, left/right, the ball, and the arrow.]

These diagrams help the person who is reading the book understand what we are describing in our writing. In the next lesson, you will get to create your own diagram to go with the last page of the book.

10. Collect mini-books and conclude the lesson. Let students know that they will have a chance to complete their Box Models and share their mini-books in the next lesson.