Preparation Guide

Level 3 Module 3

Forces and Motion

with Spotlight Lessons on the Solar System

Materials: This section lists the quantity of each material necessary for the lesson. Lesson materials may be from a *PhD Science® TEKS Edition* materials kit or they may be school supplied. In addition to the listed materials, teachers should have access to the following common classroom items: sticky notes, chart paper, pencils, a whiteboard, and markers. This section also lists items in the current lesson that are reused in future lessons. Note that items found in a typical elementary classroom (e.g., glue, tape, scissors) are not listed for reuse.

Resources: This section lists module resources (from Appendix A in the Teacher Edition) and core texts used in the lesson. Classrooms also need daily access to the module's Teacher Edition, Science Logbooks, and, if applicable, PhD Projected. A symbol (🖵) identifies resources that appear in PhD Projected. The Teacher Resource Pack provides additional supports and directions for some investigations as well as Spanish support resources with alternatives for Spanish-speaking students. The Teacher Resource Pack is available at https://greatminds.org/resources.

Preparation: This section identifies preparation teachers should complete before the lesson, including media teachers must cue before the lesson and activities that require setup. This section also describes advance preparation for upcoming lessons. For example, if teachers need to prepare 1 day in advance for an activity in Lesson 11, an advance preparation note appears in the Preparation section for Lesson 10. A symbol (🗓) identifies lessons with advance preparation notes.

Advance Materials Preparation

Several activities in this module require advance preparation. A version of this list appears in the Module Overview of the Teacher Edition. The expanded version in this guide identifies all lessons for which preparation may take longer than a planning period. A symbol (†) identifies preparation that can be done earlier than the suggested time.

Lesson	Time in Advance	Investigation	Description
10	1–2 days before†	Scooter Board Stations	Coordinate a time for the class to use the gymnasium as well as the following gym equipment: 12 scooter boards, 4 ropes, and several cones (or other markers).

Lesson	Time in Advance	Investigation	Description
15	1 day	Slowing Motion Investigation	If the burlap, foam rubber padding, or artificial grass materials have been rolled up or folded, flatten them out under books or other heavy objects.
Spotlight 2	1 day†	Temperature Investigation	Place a thermometer outside in the same location where students will collect their data. Test how long it takes for the thermometer to stabilize at a constant temperature, typically 15 to 20 minutes.

Forces and Motion Lesson Preparation

Lesson 1

Materials	**Kit Items** None	**School Supplied Items** None
Resources	☐ Lesson 1 Resource A: "The *Eagle* Has Landed" (NASA 1969b) ☐ Lesson 1 Resource B: Moon Landing Newspaper Photograph ☐ Lesson 1 Resource C: International Space Station Image ☐ Lesson 1 Resource D: "Great Views. Sleeps Six. What's It Like to Live on the International Space Station?" (BBC News, n.d.) ☐ *Moonshot: The Flight of Apollo 11* (Floca 2019)	
Preparation	☐ Cue "The *Eagle* Has Landed" audio recording (NASA 1969b) http://phdsci.link/1341. ☐ Cue "Pudding the Space Way!" video (NASA 2017a) http://phdsci.link/2137. ☐ Cue "Astronauts Kicking a Soccer Ball" video (AP Archive 2015) http://phdsci.link/1343.	

Lesson 2

Materials	**Kit Items** None	**School Supplied Items** ☐ Balls, soccer (6)
	Item Reuse ☐ Lesson 6 requires 1 of the soccer balls.	
Resources	None	
Preparation	☐ Cue "Astronauts Kicking a Soccer Ball" video (AP Archive 2015) http://phdsci.link/1343. ☐ Identify a safe, open area (such as a sports field, gym, or large empty classroom) to take students to during Lesson 2. The area should be large enough for students to freely explore the motion of a soccer ball.	

Lesson 3

Materials	**Kit Items** None	**School Supplied Items** None
Resources	None	
Preparation	☐ Cue "Young Female Argentinian Footballers Playing on Field" video http://phdsci.link/2135.	

Lesson 4

<table>
<tr><td rowspan="2">Materials</td><td>Kit Items
☐ Ball, table tennis (1)
☐ Blocks, wooden, 1” × 2” × 0.5” (2)
☐ Clipboard (1)
☐ Game spinner (1)
☐ Spinning top (1)
☐ Stopwatches (6)
☐ String (1 spool)
☐ Toy car (1)
☐ Washer, steel (1)

Module 1 Kit
☐ Safety goggles, student (24)
☐</td><td>School Supplied Items
☐ Blocks, large wooden, or books (6–10)
☐ Cotton balls (6)
☐ Craft sticks (12)
☐ Meter sticks (6)
☐ Rubber bands (5)
☐ Ruler, metric (1)
☐ Scissors (1)
☐ Spoon, plastic (1)
☐ Tape, masking (partial roll)</td></tr>
<tr><td colspan="2">Item Reuse
☐ Lesson 5 requires the prepared motion stations materials.</td></tr>
<tr><td>Resources</td><td colspan="2">☐ Lesson 1 Resource A: “The Eagle Has Landed”
☐ Lesson 4 Resource A: Motion Stations Setup Instructions
☐ Lesson 4 Resource B: Motion Stations Procedure Sheets</td></tr>
<tr><td>Preparation</td><td colspan="2">☐ Set up Motion Stations. (See Lesson 4 Resource A.) If the classroom floor is carpeted, identify a location that has floor made from a smooth, hard material (e.g., tile, wood), and set up the stations in this location for students to visit during Lessons 4 and 5.
☐ Cue marble video: http://phdsci.link/1384.</td></tr>
</table>

Lesson 5

<table>
<tr><td rowspan="3">Materials</td><td>Kit Items
☐ Clipboard (1)
☐ Toy car (1)

Module 1 Kit
☐ Safety goggles, student (24)
☐ Safety goggles, teacher (1)

Module 2 Kit
☐ Tape measure, 1.5 m (1)</td><td>School Supplied Items
☐ Highlighters, 3 colors (12 sets)
☐ Marker, permanent (1)</td></tr>
<tr><td colspan="2">Prepared Items from Previous Lessons
☐ Motion stations materials from Lesson 4</td></tr>
<tr><td colspan="2">Item Reuse
☐ Lesson 6 requires the table tennis ball.
☐ Lesson 7 requires the meter sticks and toy cars.
☐ Lesson 10 requires 4 of the stopwatches. Save all the stopwatches for Lesson 11.
☐ Lesson 13 includes the option for students to revisit the motion stations. If students will complete this optional activity, save the prepared motion station materials for Lesson 13.
☐ Lesson 15 requires the wooden blocks.
☐ Lesson 19 requires the washer.
☐ Lesson 21 requires the large wooden blocks or books.</td></tr>
<tr><td>Resources</td><td colspan="2">☐ Lesson 5 Resource: Class Speed Investigation Setup Instructions and Classroom Procedure</td></tr>
<tr><td>Preparation</td><td colspan="2">☐ Set up Motion Stations. (See Lesson 4 Resource A.)
☐ Set up materials for class speed investigation. (See Lesson 5 Resource.)</td></tr>
</table>

Lesson 6

<table>
<tr><td rowspan="2">Materials</td><td>Kit Items
☐ Ball, tennis ball (1)
☐ Film canister with lid (1)
☐</td><td>School Supplied Items
☐ Ball, bouncy (1)
☐ Ball, soccer (1)
☐ Scissors (1)</td></tr>
<tr><td colspan="2">Item Reuse
☐ Lesson 7 requires the film canister with lid.</td></tr>
<tr><td>Resources</td><td colspan="2">☐ Lesson 6 Resource: Motion Cards</td></tr>
<tr><td>Preparation</td><td colspan="2">☐ Set up a class pendulum for students to observe. To set up the pendulum, place the middle of a 30-centimeter piece of string across the top of an open film canister, and close the canister lid over the string. Hold the ends of the string between two fingers to ensure that the length of string is equal on both sides and that the film canister hangs evenly.
☐ Prepare motion cards. (See Lesson 6 Resource.)</td></tr>
</table>

Lesson 7

<table>
<tr><td rowspan="2">Materials</td><td>Kit Items
☐ Film canisters with lids (7)
☐ String (partial spool)
☐ Toy cars (6)</td><td>School Supplied Items
☐ Meter sticks (6)
☐ Pennies (140)
☐ Rulers, metric (7)
☐ Scissors (1)
☐ Tape, masking (partial roll)</td></tr>
<tr><td colspan="2">Item Reuse
☐ Lesson 8 requires the meter sticks, toy cars, 6 of the prepared pendulums, and the prepared class fair test guidelines chart.
☐ Disassemble the class pendulum and save the pennies for Lesson 11.</td></tr>
<tr><td>Resources</td><td colspan="2">☐ Lesson 7 Resource A: Pendulum Setup Instructions
☐ Lesson 7 Resource B: Airport Runway Photograph
☐ Moonshot: The Flight of Apollo 11</td></tr>
<tr><td>Preparation</td><td colspan="2">☐ Cue “Easy Rube Goldberg Ideas: Easy Rube Goldberg Machine for Kids” video (TinkerLab 2015): http://phdsci.link/1385.
☐ Follow the pendulum setup instructions (Lesson 7 Resource A) to prepare a pendulum for the class to observe. When preparing the pendulum, measure the height of the desk that the top of the pendulum will be attached to. Cut the string so that it is twice the height of the desk plus a few extra centimeters.
☐ Print a copy of Pendulum Setup Instructions (Lesson 7 Resource A) for each group.
☐ Cut a piece of string for each group to use to create their pendulum. Measure the height of the desks students will attach the top of their pendulums to. Cut each piece of string so that it is twice the height of the desk plus a few extra centimeters.</td></tr>
</table>

Lesson 8

<table>
<tr><td rowspan="3">Materials</td><td>Kit Items
☐ Toy cars (6)</td><td>School Supplied Items
☐ Meter sticks (6)
☐ Rulers, metric (13)</td></tr>
<tr><td colspan="2">Prepared Items from Previous Lessons
☐ Pendulums from Lesson 7 (6)
☐ Class fair test guidelines chart from Lesson 7 (1)</td></tr>
<tr><td colspan="2">Item Reuse
☐ Lesson 9 requires the meter sticks, toy cars, and prepared pendulums.</td></tr>
<tr><td>Resources</td><td colspan="2">☐ Lesson 8 Resource A: Pendulum Investigation Setup Instructions
☐ Lesson 8 Resource B: Pendulum Investigation Instructions</td></tr>
<tr><td rowspan="2">Preparation</td><td colspan="2">☐ Set up a pendulum for each group. (See Lesson 8 Resource A.)
☐ Print a copy of Pendulum Investigation Instructions (Lesson 8 Resource B) for each group.</td></tr>
<tr><td colspan="2">Advance Preparation for Lesson 10
☐ 1–2 Days Before: Coordinate a time for the class to use the gymnasium as well as the following gym equipment: 12 scooter boards, 4 ropes, and several cones (or other markers). Consult with the school's physical education teacher about established safety rules to reinforce with students when using this equipment. If possible, set up scooter board stations in the gymnasium. (See Lesson 10 Resource A.)</td></tr>
</table>

Lesson 9

<table>
<tr><td rowspan="3">Materials</td><td>Kit Items
☐ Toy cars (6)</td><td>School Supplied Items
☐ Meter sticks (6)
☐ Rulers, metric (6)</td></tr>
<tr><td colspan="2">Prepared Items from Previous Lessons
☐ Pendulums from Lesson 7 (6)</td></tr>
<tr><td colspan="2">Item Reuse
☐ Disassemble the pendulums and save the pennies for Lesson 11.
☐ Lesson 15 requires the meter sticks.</td></tr>
<tr><td>Resources</td><td colspan="2">☐ Lesson 9 Resource A: Conceptual Checkpoint Scenario
☐ Lesson 9 Resource B: Football Photograph</td></tr>
<tr><td>Preparation</td><td colspan="2">☐ Set up a pendulum for each group. (See Lesson 8 Resource A.)
☐ Print a copy of Pendulum Investigation Instructions (Lesson 8 Resource B) for each group.
☐ Select a pendulum release distance that was not tested during the investigation in Lesson 8. The distance should be longer than the longest distance tested or shorter than the shortest distance tested. Use the pendulum investigation procedure (Lesson 8 Resource B) to test this release distance to ensure that the results are significantly different from the class results recorded during Lesson 8. If needed, continue to test different release distances until significantly different results are achieved.
☐ Cue slingshot ride video and “Zero G Hail Mary Pass” video (NASA 2017b): http://phdsci.link/1386 and http://phdsci.link/1387.</td></tr>
</table>

Lesson 10

<table>
<tr><td rowspan="2">Materials</td><td>Kit Items
☐ Stopwatches (4)</td><td>School Supplied Items
☐ Cones (or other floor markers) (14)
☐ Ropes (4)
☐ Scissors (1)
☐ Scooter boards, plastic (12)</td></tr>
<tr><td colspan="2">Item Reuse
☐ Lesson 11 requires the stopwatches.</td></tr>
<tr><td>Resources</td><td colspan="2">☐ Lesson 10 Resource A: Scooter Board Stations Setup Instructions
☐ Lesson 10 Resource B: Scooter Board Stations Procedure Sheets</td></tr>
<tr><td>Preparation</td><td colspan="2">☐ If not done in advance, set up scooter board stations in the gymnasium. (See Lesson 10 Resource A.)
☐ Cue “Blue Ball Adventure” video (Sprice Machines 2019): http://phdsci.link/1388.</td></tr>
</table>

Lesson 11

<table>
<tr><td rowspan="2">Materials</td><td>Kit Items
☐ Blocks, wood, 1.5″ × 1.5″ × 1.5″ (7)
☐ Cups, plastic, 3 oz (14)
☐ Hooks, screw-in, 1″ (14)
☐ Stopwatches (6)
☐ String (partial spool)

Module 1 Kit
☐ Safety goggles, student (24)
☐ Safety goggles, teacher (1)</td><td>School Supplied Items
☐ Hole punch, single hole (1)
☐ Pencils, round (14)
☐ Pennies (210)
☐ Ruler (1)
☐ Scissors (1)
☐ Tape, masking (partial roll)</td></tr>
<tr><td colspan="2">Item Reuse
☐ Lesson 12 requires the pennies and prepared Atwood machines.
☐ Lesson 19 requires 1 of the stopwatches.</td></tr>
<tr><td>Resources</td><td colspan="2">☐ Lesson 11 Resource: Atwood Machine Setup Instructions</td></tr>
<tr><td>Preparation</td><td colspan="2">☐ Set up an Atwood machine for each group. (See Lesson 11 Resource.)
☐ Set up an Atwood machine for class observation. (See Lesson 11 Resource.) Alternatively, use one of the Atwood machines prepared for student groups.
☐ Test two Atwood machines that each have one cup attached to determine the number of pennies to use for the block speed demonstration. The goal of this demonstration is to show clearly how a stronger force (more pennies) acting on a block causes it to move faster than a weaker force (fewer pennies). Conduct the test by first placing 3 pennies in the cup of one Atwood machine and 6 pennies in the cup of the other Atwood machine. Then modify the number of pennies as needed if the block with 3 pennies does not move significantly slower than the block with 6 pennies.</td></tr>
</table>

Lesson 12

<table>
<tr><td rowspan="3">Materials</td><td>Kit Items
None

Module 1 Kit
☐ Safety goggles, student (24)
☐ Safety goggles, teacher (1)</td><td>School Supplied Items
☐ Pennies (210)
☐ Tape, masking (partial roll)</td></tr>
<tr><td colspan="2">Prepared Items from Previous Lessons
☐ Atwood machines from Lesson 11 (7)</td></tr>
<tr><td colspan="2">Item Reuse
☐ Lesson 13 requires 1 of the pennies and 1 of the prepared Atwood machines. Save 30 pennies for Lesson 14. Save 180 pennies and 6 prepared Atwood machines for Lesson 17.</td></tr>
<tr><td>Resources</td><td colspan="2">☐ Lesson 12 Resource A: Dogs Playing Tug-of-War Photograph
☐ Lesson 12 Resource B: Moving Block Demonstration Setup Instructions and Classroom Procedure</td></tr>
<tr><td>Preparation</td><td colspan="2">☐ Set up and test the moving block demonstration. (See Lesson 12 Resource B.)</td></tr>
</table>

Lesson 13

<table>
<tr><td rowspan="3">Materials</td><td>Kit Items
None</td><td>School Supplied Items
☐ Classroom objects (e.g., book, pencil, eraser) (12)
☐ Penny (1)
☐ Whiteboards, personal (12, optional)

Optional Balloon Rocket Extension
☐ Balloons (12)
☐ Straws, plastic (12)
☐ String (1 spool)</td></tr>
<tr><td colspan="2">Prepared Items from Previous Lessons
☐ Atwood machine from Lesson 11 (1)
☐ Motion stations materials from Lesson 4 (optional)</td></tr>
<tr><td colspan="2">Item Reuse
☐ Lesson 14 requires the penny and the prepared Atwood machine.</td></tr>
<tr><td>Resources</td><td colspan="2">☐ Moonshot: The Flight of Apollo 11</td></tr>
<tr><td>Preparation</td><td colspan="2">☐ Cue “Apollo 11 Launch” video (NASA 1969a): http://phdsci.link/1392.</td></tr>
</table>

Lesson 14

Materials	**Kit Items** None	**School Supplied Items** ☐ Pennies (30) ☐ Whiteboards, personal (12, optional)
	Prepared Items from Previous Lessons ☐ Atwood machine from Lesson 11 (1)	
Resources	None	
Preparation	☐ Cue "Astronauts Kicking a Soccer Ball" video (AP Archive 2015) and "International Toys in Space: Soccer" (NASA Video 2013): http://phdsci.link/1343 and http://phdsci.link/1393.	
	Advance Preparation for Lesson 15 ☐ **1 Day Before:** If the burlap, foam rubber padding, or artificial grass materials have been rolled up or folded, flatten them out under books or other heavy objects.	

Lesson 15

Materials	**Kit Items** ☐ Bearing balls, 1" diameter (6) ☐ Blocks, wood, 1" × 2" × 0.5" (6) ☐ Burlap, 12" × 24" (6) ☐ Foam rubber padding, 12" × 24" (6) ☐ Grass, artificial, 12" × 24" (6) ☐ Rulers, grooved (6)	**School Supplied Items** ☐ Meter sticks (6) ☐ Pencils (6, optional) ☐ Tape, masking (partial roll)
Resources	None	
Preparation	☐ Cue golfer hitting golf ball video and "Frustration at the Postage Stamp" video (Golf Channel 2016): http://phdsci.link/1396 and http://phdsci.link/1397.	

Lesson 16

Materials	**Kit Items** None	**School Supplied Items** None
Resources	☐ Lesson 16 Resource: Golf Course Photograph	
Preparation	None	

Lesson 17

Materials	**Kit Items** None	**School Supplied Items** ☐ Notebooks, single-subject (2) ☐ Pennies (180)
	Prepared Items from Previous Lessons ☐ Atwood machines from Lesson 11 (6)	
	Item Reuse ☐ Lesson 19 requires 2 of the pennies.	
Resources	☐ Lesson 17 Resource: Notebook Demonstration Setup Instructions	
Preparation	☐ Set up notebooks for notebook demonstration. (See Lesson 17 Resource.)	

Lesson 18

Materials	**Kit Items** None	**School Supplied Items** ☐ Glue sticks (12) ☐ Scissors (1)
Resources	☐ Lesson 18 Resource: Conceptual Checkpoint Force Models	
Preparation	☐ Cue "Calder: Hypermobility *Triple Gong*, c. 1948" video (Whitney Museum of American Art 2017), "Astronauts Kicking a Soccer Ball" video (AP Archive 2015), hockey video, and children playing with wooden figures video: http://phdsci.link/1398, http://phdsci.link/1343, http://phdsci.link/1399, http://phdsci.link/1400. ☐ Prepare Conceptual Checkpoint force models. (See Lesson 18 Resource.)	

Lesson 19

<table>
<tr><td rowspan="2">Materials</td><td>Kit Items
☐ Clothespins, wooden, 3” (2)
☐ Compasses, mini (4)
☐ Magnets, bar, with N/S labels (8)
☐ Magnets, ceramic ring (24)
☐ Magnets, ceramic ring, coated (2)
☐ Screws, brass (2)
☐ Screws, steel (2)
☐ Stopwatch (1)
☐ Washers, brass (2)
☐ Washers, steel (2)</td><td>School Supplied Items
☐ Aluminum foil, 4” × 4” (2)
☐ Book, thick (1)
☐ Book, thin (1)
☐ Cloths, cotton, 6” × 6” (2 pieces)
☐ Construction paper, 12” × 18” (2 sheets)
☐ Cork stoppers (2)
☐ Cups, plastic, 16 oz (3)
☐ Marker, permanent (1)
☐ Paper, printer, 8.5” × 11” (1 sheet)
☐ Paper clips, large, metal (62)
☐ Paper towels (1 roll)
☐ Pencils, regular or round (2)
☐ Pennies (2)
☐ Ruler, metric (1)
☐ Scissors (1)
☐ Tape, masking (partial roll)
☐ Water (12 oz)</td></tr>
<tr><td colspan="2">Item Reuse
☐ Lesson 20 requires the ceramic ring magnets and the prepared class magnet list.
☐ Lesson 21 requires 1 of the paper clips.
☐ Lesson 26 requires the stopwatch.</td></tr>
<tr><td>Resources</td><td colspan="2">☐ Lesson 19 Resource A: Magnet Stations Setup Instructions
☐ Lesson 19 Resource B: Magnet Stations Procedure Sheets</td></tr>
<tr><td>Preparation</td><td colspan="2">☐ Set up Magnet Stations. (See Lesson 19 Resource A.)</td></tr>
</table>

Lesson 20

<table>
<tr><td rowspan="3">Materials</td><td>Kit Items
☐ Cloth, wool (1)
☐ Magnets, ceramic ring (24)</td><td>School Supplied Items
☐ Balloon (1)
☐ Glue stick (1)
☐ Scissors (1)
☐ Sink with running water (or foam cup filled with water and plastic basin) (1)</td></tr>
<tr><td colspan="2">Prepared Items from Previous Lessons
☐ Class magnet list from Lesson 19 (1)</td></tr>
<tr><td colspan="2">Item Reuse
☐ Lesson 21 requires 1 of the ceramic ring magnets and the wool cloth.</td></tr>
<tr><td>Resources</td><td colspan="2">☐ Lesson 20 Resource A: Investigation Questions
☐ Lesson 20 Resource B: Bending Water Demonstration Setup Instructions and Classroom Procedure</td></tr>
<tr><td>Preparation</td><td colspan="2">☐ Cue children playing with wooden figures video: http://phdsci.link/1400.
☐ Prepare chart paper with investigation questions. (See Lesson 20 Resource A.)
☐ Set up and test bending water demonstration. (See Lesson 20 Resource B.)</td></tr>
</table>

Lesson 21

<table>
<tr><td rowspan="2">Materials</td><td>Kit Items
☐ Cloth, wool (6)
☐ Magnet, ceramic ring (1)
☐</td><td>School Supplied Items
☐ Balloons (6)
☐ Blocks, large wooden, or books (6–10)
☐ Paper clip, large, metal (1)
☐ Ruler, metric (1)
☐ Soda cans, aluminum (6)
☐ Tape, masking (partial roll)</td></tr>
<tr><td>Resources</td><td colspan="2">☐ Lesson 21 Resource A: Conceptual Checkpoint Setup Instructions
☐ Lesson 21 Resource B: Conceptual Checkpoint Questions
☐ Lesson 21 Resource C: Magnetic Wristband Photograph</td></tr>
<tr><td>Preparation</td><td colspan="2">☐ Inflate balloons for static soda can activity. Each group needs an inflated balloon.
☐ Set up materials for Conceptual Checkpoint. (See Lesson 21 Resource A.)
☐ Cue “Cooking in Space: Whole Red Rice and Turmeric Chicken” video (ESA 2015): http://phdsci.link/1401.</td></tr>
</table>

Lesson 22

Materials	Kit Items None	School Supplied Items None
Resources	☐ Lesson 22 Resource A: "So Repulsive, It's Attractive" (D'Alto 2009) ☐ Lesson 22 Resource B: Maglev Train Image ☐ Lesson 22 Resource C: Uses of Magnets Texts	
Preparation	☐ Print enough copies of Uses of Magnets Texts (Lesson 22 Resource C) for each student pair to receive one of the texts during the lesson. Half the pairs should receive "Sideways Elevator" (SuperScience 2018), and the other half should receive "Sportswear with Zip" (McCally 2014). ☐ Cue maglev train video, magnetic zipper video (maayan555 2018), and sideways elevator video (Hanoel Elevator 2021): http://phdsci.link/1407, http://phdsci.link/1408, and http://phdsci.link/1409.	

Lesson 23

Materials	Kit Items ☐ Box, cardboard, 8" × 5" × 3", unassembled (1)	School Supplied Items ☐ Scissors (1)
	Item Reuse ☐ Lesson 24 requires the prepared cardboard box.	
Resources	☐ Lesson 23 Resource A: Engineering Design Process ☐ Lesson 23 Resource B: Detailed Engineering Design Process ☐ Lesson 23 Resource C: Cardboard Box Assembly Instructions ☐ *Marvelous Mattie: How Margaret E. Knight Became an Inventor* (McCully 2006)	
Preparation	☐ Cue "Raw Video: Tool Bag Lost during Space Walk" (AP 2008): http://phdsci.link/1410. ☐ Assemble a cardboard box for students to observe. (See Lesson 23 Resource C.)	

Lesson 24

<table>
<tr><td rowspan="4">Materials</td><td>Kit Items
☐ Boxes, cardboard, 8” × 5” × 3”, unassembled (5)
☐ Glue gun with glue sticks (1)
☐ Magnets, ceramic disc (40)
☐ Magnets, square, adhesive-backed (120)
☐ String (partial spool)
☐ Toy tools, plastic (24)</td><td>School Supplied Items
☐ Scissors (1)
☐ Tape, masking (partial roll)</td></tr>
<tr><td colspan="2">Prepared Items from Previous Lessons
☐ Cardboard box from Lesson 23 (1)</td></tr>
<tr><td colspan="2">Item Reuse
☐ Lesson 25 requires the glue gun with glue sticks and the prepared Engineering Challenge materials.</td></tr>
<tr><td>Resources</td><td colspan="2">☐ Lesson 23 Resource C: Cardboard Box Assembly Instructions</td></tr>
<tr><td>Preparation</td><td colspan="2">☐ Assemble a cardboard box for each group. (See Lesson 23 Resource C.)</td></tr>
</table>

Lesson 25

<table>
<tr><td rowspan="3">Materials</td><td>Kit Items
☐ Glue gun with glue sticks (1)</td><td>School Supplied Items
None</td></tr>
<tr><td colspan="2">Prepared Items from Previous Lessons
☐ Engineering Challenge materials from Lesson 24</td></tr>
<tr><td colspan="2">Item Reuse
☐ Lesson 26 requires the glue gun with glue sticks and the prepared Engineering Challenge materials.</td></tr>
<tr><td>Resources</td><td colspan="2">None</td></tr>
<tr><td>Preparation</td><td colspan="2">None</td></tr>
</table>

Lesson 26

Materials	**Kit Items** ☐ Baking sheet, magnetic metal (1) ☐ Glue gun with glue sticks (1) ☐ Stopwatch (1) **Module 1 Kit** ☐ Safety goggles, student (24) ☐ Safety goggles, teacher (1)	**School Supplied Items** None
	Prepared Items from Previous Lessons ☐ Engineering Challenge materials from Lesson 24	
	Item Reuse ☐ Lesson 27 requires the prepared Engineering Challenge prototypes.	
Resources	☐ Lesson 26 Resource: Engineering Challenge Testing Procedures	
Preparation	☐ Print a copy of Engineering Challenge Testing Procedures (Lesson 26 Resource) for each group.	

Lesson 27

Materials	**Kit Items** None	**School Supplied Items** None
	Prepared Items from Previous Lessons ☐ Engineering Challenge prototypes from Lesson 26	
Resources	None	
Preparation	None	

Lesson 28

No materials or preparation required.

Lesson 29

Materials	**Kit Items** None	**School Supplied Items** None
Resources	None	
Preparation	☐ Cue dogsled video and sled sliding down hill video: http://phdsci.link/1414 and http://phdsci.link/1413.	

Lesson 30

Materials	Kit Items None	School Supplied Items ☐ Scissors (1)
Resources	☐ Lesson 30 Resource: Content Standards	
Preparation	☐ Score End-of-Module Assessments and write individual feedback. ☐ Select End-of-Module Assessment responses to share with students. ☐ Prepare visual for student connections between module learning and content standards. (See Lesson 30 Resource).	

Solar System Lesson Preparation

Lesson 1

Materials	Kit Items None	School Supplied Items None
Resources	None	
Preparation	☐ Cue the solar eclipse over Mackay and total solar eclipse over Oregon videos: http://phdsci.link/1980 and http://phdsci.link/1981.	
	Advance Preparation for Lesson 2 ☐ **1 Day Before:** Place a thermometer outside at about the same time of day and in the same location where students will collect their data. Test how long it takes for the thermometer to stabilize at a constant temperature. Depending on outside temperatures, the thermometer reading should stabilize within 15 to 20 minutes. On the day of the lesson, place the thermometers in direct sunlight until they have stabilized at a constant temperature before distributing them to groups.	

Lesson 2

Materials	**Kit Items** ☐ Stopwatches (6) **Module 1 Kit** ☐ Safety goggles, student (24) ☐ Safety goggles, teacher (1) **Module 2 Kit** ☐ Thermometers, Celsius, plastic back (6)	**School Supplied Items** ☐ Cardboard circles, 12” diameter (6) ☐ Scissors (1)
Resources	☐ Lesson 2 Resource: Temperature Investigation Procedure Sheet	
Preparation	☐ Check the local weather forecast to identify a day when the weather will be sunny. If it is not possible to teach Lesson 2 outside on a sunny day, consider using a heat lamp to represent the Sun. ☐ Cut out enough 12-inch cardboard circles to give one to each group. ☐ Prepare to distribute a copy of Lesson 2 Resource to each group.	

Lesson 3

Materials	**Kit Items** None	**School Supplied Items** None
Resources	☐ Lesson 3 Resource A: Scientist Prepares to Record Sound Photograph ☐ Lesson 3 Resource B: Daytime and Nighttime Animals ☐ Lesson 3 Resource C: Solar Eclipse Sound Observations	
Preparation	☐ Cue the daytime animal sounds and nighttime animal sounds audio clips: http://phdsci.link/1982 and http://phdsci.link/1983. ☐ Prepare to distribute a copy of Lesson 3 Resource C to student pairs.	

Lesson 4

Materials	**Kit Items** ☐ String (144 m) ☐ Tape measure, 3 m (1)	**School Supplied Items** ☐ Cardstock, 8.5" x 11" (8 sheets) ☐ Marker (1) ☐ Scissors (1) ☐ Tape, masking (partial roll)
Resources	☐ Lesson 4 Resource A: Star Photographs ☐ Lesson 4 Resource B: Alpha Centauri A Photograph ☐ Lesson 4 Resource C: Stars Diagram ☐ Lesson 4 Resource D: Star Cutouts ☐ Lesson 4 Resource E: Star Viewfinder Preparation Instructions ☐ Lesson 4 Resource F: Distance Measuring Tool Preparation Instructions	
Preparation	☐ Prepare to distribute a color copy of Lesson 4 Resource C to each student pair. ☐ Prior to the lesson, identify a large area for the distance investigation. ☐ Prepare star cutouts. (See Lesson 4 Resource D.) ☐ Prepare star viewfinders. (See Lesson 4 Resource E.) ☐ Prepare distance measuring tools. (See Lesson 4 Resource F.)	

Lesson 5

Materials	**Kit Items** None	**School Supplied Items** ☐ Scissors (1)
Resources	☐ Lesson 4 Resource C: Stars Diagram ☐ Lesson 5 Resource A: Planet Cards ☐ Lesson 5 Resource B: Mercury and Venus Photographs	
Preparation	☐ Prepare to distribute planet cards. (See Lesson 5 Resource A.)	

Lesson 6

Materials	**Kit Items** ☐ Balls, polystyrene, 1" diameter (6) ☐ Balls, polystyrene, 3" diameter (6) ☐ Clay, modeling, nonhardening (1.5 lbs) ☐ Dowels, wooden, 12" (12)	**School Supplied Items** ☐ Basketballs or other similarly sized spherical objects (6) ☐ Cups, plastic, 8 oz (6) ☐ Scissors (1)
Resources	☐ Lesson 6 Resource: Sun and Moon Cards	
Preparation	☐ Prepare to distribute Sun and Moon cards. (See Lesson 6 Resource.)	

Lesson 7

Materials	**Kit Items** ☐ Tape measure, 3 m (1)	**School Supplied Items** ☐ Paper, colored, 8.5” x 11” (1 sheet) ☐ Scissors (1) ☐ Tape, masking (partial roll)
Resources	☐ Lesson 7 Resource A: Sun and Moon Investigation Setup ☐ Lesson 7 Resource B: Solar Eclipse Photograph	
Preparation	☐ Set up Sun and Moon Investigation. (See Lesson 7 Resource A.) Prior to the lesson, identify a large area in which to set up this investigation.	

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Credits