




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*® Texas materials kit, or the materials may be school-supplied items. In addition to having the listed materials, teachers should have access to the following common classroom items: sticky notes, chart paper, pencils, a whiteboard, and markers.

Resources: This section lists module resources (from the Module Resources section 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, digital slides. A symbol () identifies resources that appear in the digital slides. Additional supports and Spanish resources are available in the Implementation Resources and Level Overview sections of the digital platform.

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.






Forces and Motion | Advance Preparation

Some 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†	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).
11	1 day†	Speed Investigation	Set up two ramps per group for the speed investigation.
11	1 day†	Magnet Stations	Prepare materials for magnet stations.
23	1–5 days†	Researching Mechanical Engineers	Coordinate a time for the class to use computers or tablets for research on mechanical engineers.

Forces and Motion | Lesson Preparation


Lesson 1

Materials	<p>Kit Items None</p> <p>School-Supplied Items None</p>
Resources	<ul style="list-style-type: none"> <input type="checkbox"/> Lesson 1 Resource A: “The <i>Eagle</i> Has Landed” (NASA 1969b) <input type="checkbox"/> Lesson 1 Resource B: Moon Landing Newspaper Photograph  <input type="checkbox"/> Lesson 1 Resource C: International Space Station Image  <input type="checkbox"/> Lesson 1 Resource D: “Great Views. Sleeps Six. What’s It Like to Live on the International Space Station?” (BBC News, n.d.) <input type="checkbox"/> <i>Moonshot: The Flight of Apollo 11</i> (Floci 2019)
Preparation	<ul style="list-style-type: none"> <input type="checkbox"/> Cue “The <i>Eagle</i> Has Landed” audio recording (http://phdsci.link/1341).  <input type="checkbox"/> Cue “Pudding the Space Way!” video (NASA 2017a) (http://phdsci.link/2137).  <input type="checkbox"/> Cue “Astronauts Kicking a Soccer Ball” video (http://phdsci.link/1343). 

Lesson 2

Materials	<p>Kit Items None</p> <p>School-Supplied Items</p> <ul style="list-style-type: none"> <input type="checkbox"/> Balls, soccer (6) <p>Item Reuse</p> <ul style="list-style-type: none"> <input type="checkbox"/> Lesson 6 requires 1 of the soccer balls.
Resources	None
Preparation	<ul style="list-style-type: none"> <input type="checkbox"/> Cue “Astronauts Kicking a Soccer Ball” video (http://phdsci.link/1343).  <input type="checkbox"/> Identify a safe, open area (such as a sports field, gymnasium, 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	<p>Kit Items None</p> <p>School-Supplied Items None</p>
Resources	None
Preparation	<input type="checkbox"/> Cue “Young Female Argentinian Footballers Playing on Field” video (http://phdsci.link/2135). 

Lesson 4

Materials	<p>Kit Items</p> <ul style="list-style-type: none"> <input type="checkbox"/> Ball, table tennis (1) <input type="checkbox"/> Blocks, wooden, 1" x 2" x 0.5" (2) <input type="checkbox"/> Clipboard (1) <input type="checkbox"/> Cotton balls (6) <input type="checkbox"/> Craft sticks (12) <input type="checkbox"/> Game spinner (1) <input type="checkbox"/> Meter sticks (6) <input type="checkbox"/> Spinning top (1) <input type="checkbox"/> Toy car (1) <input type="checkbox"/> Washer, steel (1) <p>Module 1 Kit</p> <ul style="list-style-type: none"> <input type="checkbox"/> Safety goggles, student (24) <input type="checkbox"/> Safety goggles, teacher (1) <input type="checkbox"/> Spoon, plastic (1) <input type="checkbox"/> String (30 cm) <input type="checkbox"/> Timers, digital (6) <p>Module 2 Kit</p> <ul style="list-style-type: none"> <input type="checkbox"/> Rubber bands (5) <input type="checkbox"/> Ruler, metric (1) <p>School-Supplied Items</p> <ul style="list-style-type: none"> <input type="checkbox"/> Blocks, large, wooden, or books (6–12) <input type="checkbox"/> Desk or table (1) <input type="checkbox"/> Scissors (1) <input type="checkbox"/> Tape, masking (partial roll) <p>Item Reuse</p> <ul style="list-style-type: none"> <input type="checkbox"/> Lesson 5 requires the prepared motion stations materials.
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Lesson 4 *continued*

Resources	<input type="checkbox"/> Lesson 1 Resource A: “The <i>Eagle</i> Has Landed” <input type="checkbox"/> Lesson 4 Resource A: Motion Stations Setup Instructions <input type="checkbox"/> Lesson 4 Resource B: Motion Stations Procedure Sheets
Preparation	<input type="checkbox"/> Set up motion stations. (See Lesson 4 Resource A.) If the classroom floor is carpeted, identify a location that has a floor made from a smooth, hard material such as tile or wood, and set up the stations in this location for students to visit during Lessons 4 and 5. <input type="checkbox"/> Cue marble video (http://phdsci.link/1384). 


Lesson 5

Materials	<p>Kit Items</p> <input type="checkbox"/> Clipboards (12) <input type="checkbox"/> Tape measures, metric (5) <input type="checkbox"/> Toy cars (6)
	<p>Module 1 Kit</p> <input type="checkbox"/> Safety goggles, student (24) <input type="checkbox"/> Safety goggles, teacher (1) <input type="checkbox"/> Tape measure, metric (1) <input type="checkbox"/> Timers, digital (6)
	<p>School-Supplied Items</p> <input type="checkbox"/> Tape, masking (partial roll)
	<p>Prepared Items from Previous Lessons</p> <input type="checkbox"/> Motion stations materials from Lesson 4
	<p>Item Reuse</p> <input type="checkbox"/> Lesson 6 requires the table tennis ball and 1 of the meter sticks. <input type="checkbox"/> Lesson 7 requires the meter sticks and toy cars. <input type="checkbox"/> Lesson 10 requires 4 of the digital timers. Save all the digital timers for Lesson 11. <input type="checkbox"/> Lesson 13 includes the option for students to revisit the motion stations. If students will complete this optional activity, save the prepared motion stations materials for Lesson 13. <input type="checkbox"/> Lesson 15 requires the two small wooden blocks. <input type="checkbox"/> Lesson 19 requires the steel washer. <input type="checkbox"/> Lesson 21 requires the large wooden blocks or books.
Resources	<input type="checkbox"/> Lesson 5 Resource A: Speed Investigation Setup Instructions <input type="checkbox"/> Lesson 5 Resource B: Speed Investigation Procedure Sheets
Preparation	<input type="checkbox"/> Set up motion stations. (See Lesson 4 Resource A.) <input type="checkbox"/> Cue pinwheel video (http://phdsci.link/2951). <input type="checkbox"/> Prepare materials for speed investigation. Ensure that each group has a smooth floor and at least 3 meters of clear space. (See Lesson 5 Resource A.) <input type="checkbox"/> Prepare to distribute speed investigation procedure sheets to each group. (See Lesson 5 Resource B.)


Lesson 6

Materials	<p>Kit Items</p> <ul style="list-style-type: none"> <input type="checkbox"/> Ball, bouncy (1) <input type="checkbox"/> Ball, table tennis (1) <input type="checkbox"/> Film canister with lid (1) <input type="checkbox"/> Meter stick (1) <p>Module 1 Kit</p> <ul style="list-style-type: none"> <input type="checkbox"/> String (30 cm) <p>School-Supplied Items</p> <ul style="list-style-type: none"> <input type="checkbox"/> Ball, soccer (1) <input type="checkbox"/> Scissors (1) <p>Item Reuse</p> <ul style="list-style-type: none"> <input type="checkbox"/> Lesson 7 requires the film canister with lid.
Resources	<ul style="list-style-type: none"> <input type="checkbox"/> Lesson 6 Resource: Motion Cards
Preparation	<ul style="list-style-type: none"> <input type="checkbox"/> Set up a class pendulum for students to observe. To set up the pendulum, place the middle of a 30 cm 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. <input type="checkbox"/> Prepare motion cards for each group. (See Lesson 6 Resource.)


Lesson 7

Materials	<p>Kit Items</p> <ul style="list-style-type: none"> <input type="checkbox"/> Film canisters with lids (7) <input type="checkbox"/> Meter sticks (6) <input type="checkbox"/> Toy cars (6) <p>Module 1 Kit</p> <ul style="list-style-type: none"> <input type="checkbox"/> String (partial spool) <p>Module 2 Kit</p> <ul style="list-style-type: none"> <input type="checkbox"/> Rulers, metric (7) <p>School-Supplied Items</p> <ul style="list-style-type: none"> <input type="checkbox"/> Desks (7) <input type="checkbox"/> Pennies (140) <input type="checkbox"/> Scissors (1) <input type="checkbox"/> Tape, masking (6 rolls) <p>Item Reuse</p> <ul style="list-style-type: none"> <input type="checkbox"/> Lesson 8 requires the meter sticks, toy cars, 6 of the prepared pendulums, and the prepared class fair test guidelines chart. <input type="checkbox"/> Disassemble the class pendulum and save the pennies for Lesson 11.
Resources	<ul style="list-style-type: none"> <input type="checkbox"/> Lesson 7 Resource A: Pendulum Setup Instructions <input type="checkbox"/> Lesson 7 Resource B: Airport Runway Photograph  <input type="checkbox"/> <i>Moonshot: The Flight of Apollo 11</i>






Lesson 7 *continued*

Preparation	<ul style="list-style-type: none"> <input type="checkbox"/> Cue “Chain Reaction Challenge” video (http://phdsci.link/2472).  <input type="checkbox"/> 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. <input type="checkbox"/> Prepare to distribute a copy of the pendulum setup instructions to each group. (See Lesson 7 Resource A.) <input type="checkbox"/> Measure the height of the desks that students will use in the pendulum exploration. Cut a piece of string for each group. The string should be twice the height of the desk plus a few extra centimeters.
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Lesson 8

Materials	<p>Kit Items</p> <ul style="list-style-type: none"> <input type="checkbox"/> Meter sticks (6) <input type="checkbox"/> Toy cars (6) <p>Module 2 Kit</p> <ul style="list-style-type: none"> <input type="checkbox"/> Rulers, metric (6) <p>School-Supplied Items</p> <ul style="list-style-type: none"> <input type="checkbox"/> Scissors (1) <input type="checkbox"/> Tape, masking (6 rolls) <p>Prepared Items from Previous Lessons</p> <ul style="list-style-type: none"> <input type="checkbox"/> Pendulums from Lesson 7 (6) <input type="checkbox"/> Class fair test guidelines chart started in Lesson 7 (1) <p>Item Reuse</p> <ul style="list-style-type: none"> <input type="checkbox"/> Lesson 9 requires the meter sticks, toy cars, and prepared pendulums.
Resources	<ul style="list-style-type: none"> <input type="checkbox"/> Lesson 8 Resource A: Pendulum Investigation Setup Instructions <input type="checkbox"/> Lesson 8 Resource B: Pendulum Investigation Instructions
<p>Preparation</p> 	<ul style="list-style-type: none"> <input type="checkbox"/> Set up a pendulum for each group. (See Lesson 8 Resource A.) <input type="checkbox"/> Prepare to distribute a copy of the pendulum investigation instructions to each group. (See Lesson 8 Resource B.) <p>Advance Preparation for Lesson 10</p> <ul style="list-style-type: none"> <input type="checkbox"/> 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.

Lesson 9

Materials	<p>Kit Items</p> <ul style="list-style-type: none"> <input type="checkbox"/> Meter sticks (6) <input type="checkbox"/> Toy cars (6) <p>Module 2 Kit</p> <ul style="list-style-type: none"> <input type="checkbox"/> Rulers, metric (6) <p>School-Supplied Items</p> <ul style="list-style-type: none"> <input type="checkbox"/> Tape, masking (6 rolls) <p>Prepared Items from Previous Lessons</p> <ul style="list-style-type: none"> <input type="checkbox"/> Pendulums from Lesson 7 (6) <p>Item Reuse</p> <ul style="list-style-type: none"> <input type="checkbox"/> Disassemble the pendulums and save the pennies for Lesson 11. <input type="checkbox"/> Lesson 15 requires the meter sticks.
Resources	<ul style="list-style-type: none"> <input type="checkbox"/> Lesson 9 Resource A: Slingshot Ride Photograph  <input type="checkbox"/> Lesson 9 Resource B: Conceptual Checkpoint  <input type="checkbox"/> Lesson 9 Resource C: Football Photograph 
Preparation	<ul style="list-style-type: none"> <input type="checkbox"/> 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. <input type="checkbox"/> Prepare to distribute a copy of Lesson 9 Resource B to each student. <input type="checkbox"/> Cue slingshot ride video (http://phdsci.link/1386)  and “Zero G Hail Mary Pass” video (NASA 2017b) (http://phdsci.link/1387). 


Lesson 10

Materials	<p>Kit Items</p> <ul style="list-style-type: none"> <input type="checkbox"/> Ropes (4) <p>Module 1 Kit</p> <ul style="list-style-type: none"> <input type="checkbox"/> Timers, digital (4) <p>School-Supplied Items</p> <ul style="list-style-type: none"> <input type="checkbox"/> Cones (or other floor markers) (6) <input type="checkbox"/> Scooter boards, plastic (12) <p>Item Reuse</p> <ul style="list-style-type: none"> <input type="checkbox"/> Lesson 11 requires the digital timers.
Resources	<ul style="list-style-type: none"> <input type="checkbox"/> Lesson 10 Resource A: Scooter Board Stations Setup Instructions <input type="checkbox"/> Lesson 10 Resource B: Scooter Board Stations Procedure Sheets
Preparation	<ul style="list-style-type: none"> <input type="checkbox"/> Set up scooter board stations in the gymnasium. (See Lesson 10 Resource A.) <input type="checkbox"/> Cue the plastic balls on a track video (http://phdsci.link/2473). 


Lesson 11

<p>Materials</p>	<p>Kit Items</p> <ul style="list-style-type: none"> <input type="checkbox"/> Blocks, wooden, 1.5" × 1.5" × 1.5" (7) <input type="checkbox"/> Cups, plastic, 3 oz (14) <input type="checkbox"/> Hooks, screw-in, 1" (14) <p>Module 1 Kit</p> <ul style="list-style-type: none"> <input type="checkbox"/> Safety goggles, student (24) <input type="checkbox"/> Safety goggles, teacher (1) <input type="checkbox"/> String (partial spool) <input type="checkbox"/> Timers, digital (6) <p>Module 2 Kit</p> <ul style="list-style-type: none"> <input type="checkbox"/> Ruler (1) <p>School-Supplied Items</p> <ul style="list-style-type: none"> <input type="checkbox"/> Desks or tables (7) <input type="checkbox"/> Hole punch, single-hole (1) <input type="checkbox"/> Pencils, round (14) <input type="checkbox"/> Pennies (210) <input type="checkbox"/> Scissors (1) <input type="checkbox"/> Tape, masking (partial roll) <p>Item Reuse</p> <ul style="list-style-type: none"> <input type="checkbox"/> Lesson 12 requires the pennies and prepared Atwood machines. <input type="checkbox"/> Lesson 19 requires 1 of the digital timers.
<p>Resources</p>	<ul style="list-style-type: none"> <input type="checkbox"/> Lesson 11 Resource: Atwood Machine Setup Instructions
<p>Preparation</p>	<ul style="list-style-type: none"> <input type="checkbox"/> Prepare an Atwood machine for each group and one for class observation. (See Lesson 11 Resource.) <input type="checkbox"/> Test two Atwood machines, each with one cup attached, to determine the number of pennies to use for the block speed demonstration. The goal of this demonstration is to clearly show 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.



Lesson 12

<p>Materials</p>	<p>Kit Items None</p> <p>Module 1 Kit</p> <ul style="list-style-type: none"> <input type="checkbox"/> Safety goggles, student (24) <input type="checkbox"/> Safety goggles, teacher (1) <p>School-Supplied Items</p> <ul style="list-style-type: none"> <input type="checkbox"/> Pennies (210) <input type="checkbox"/> Tape, masking (partial roll) <p>Prepared Items from Previous Lessons</p> <ul style="list-style-type: none"> <input type="checkbox"/> Atwood machines from Lesson 11 (7) <p>Item Reuse</p> <ul style="list-style-type: none"> <input type="checkbox"/> Lesson 13 requires 1 of the pennies and 1 of the prepared Atwood machines. <input type="checkbox"/> Lesson 14 requires 30 pennies. <input type="checkbox"/> Lesson 17 requires 180 pennies and 6 prepared Atwood machines.
<p>Resources</p>	<ul style="list-style-type: none"> <input type="checkbox"/> Lesson 11 Resource: Atwood Machine Setup Instructions <input type="checkbox"/> Lesson 12 Resource A: Dogs Playing Tug-of-War Photograph  <input type="checkbox"/> Lesson 12 Resource B: Moving Block Demonstration Setup Instructions and Procedure
<p>Preparation</p>	<ul style="list-style-type: none"> <input type="checkbox"/> Prepare an Atwood machine for each group. Place a piece of masking tape in the middle of each desk or table. (See Lesson 11 Resource.) <input type="checkbox"/> Prepare and test the moving block demonstration. (See Lesson 12 Resource B.)



Lesson 13

Materials	<p>Kit Items None</p> <p>Module 1 Kit <input type="checkbox"/> Safety goggles, teacher (1)</p> <p>School-Supplied Items <input type="checkbox"/> Classroom objects (e.g., book, pencil, eraser) (12) <input type="checkbox"/> Penny (1) <input type="checkbox"/> Whiteboards, personal (12, optional)</p> <p>Optional Balloon Rocket Extension Items <input type="checkbox"/> Balloons (12) <input type="checkbox"/> Straws, plastic (12) <input type="checkbox"/> String (partial spool)</p> <p>Prepared Items from Previous Lessons <input type="checkbox"/> Atwood machine from Lesson 11 (1) <input type="checkbox"/> Motion stations materials from Lesson 4 (optional)</p> <p>Item Reuse <input type="checkbox"/> Lesson 14 requires the penny and the prepared Atwood machine.</p>
Resources	<input type="checkbox"/> <i>Moonshot: The Flight of Apollo 11</i>
Preparation	<input type="checkbox"/> Cue “Apollo 11 Launch” video (NASA 1969a) (http://phdsci.link/1392). 


Lesson 14

Materials	<p>Kit Items None</p> <p>Module 1 Kit <input type="checkbox"/> Safety goggles, teacher (1)</p> <p>School-Supplied Items <input type="checkbox"/> Pennies (30) <input type="checkbox"/> Whiteboards, personal (12, optional)</p> <p>Prepared Items from Previous Lessons <input type="checkbox"/> Atwood machine from Lesson 11 (1)</p>
Resources	None
Preparation	<input type="checkbox"/> Cue “Astronauts Kicking a Soccer Ball” video (http://phdsci.link/1343)  and “International Toys in Space: Soccer” video (NASA Video 2013) (http://phdsci.link/1393). 

Lesson 15

Materials	<p>Kit Items</p> <ul style="list-style-type: none"> <input type="checkbox"/> Blocks, wooden, 1" × 2" × 0.5" (6) <input type="checkbox"/> Burlap, 12" × 24" (6) <input type="checkbox"/> Foam rubber padding, 12" × 24" (6) <input type="checkbox"/> Grass, artificial, 12" × 24" (6) <input type="checkbox"/> Marbles, $\frac{5}{8}$" (6) <input type="checkbox"/> Meter sticks (6) <input type="checkbox"/> Rulers, grooved (6) <p>Module 1 Kit</p> <ul style="list-style-type: none"> <input type="checkbox"/> Safety goggles, student (24) <input type="checkbox"/> Safety goggles, teacher (1) <p>School-Supplied Items</p> <ul style="list-style-type: none"> <input type="checkbox"/> Pencils (6, optional) <input type="checkbox"/> Tape, masking (partial roll)
Resources	None
Preparation	<ul style="list-style-type: none"> <input type="checkbox"/> Cue golfer hitting golf ball video (http://phdsci.link/1396)  and golf ball rolling video (http://phdsci.link/2474). 








Lesson 16

Materials	<p>Kit Items</p> None
Resources	<ul style="list-style-type: none"> <input type="checkbox"/> Lesson 16 Resource: Golf Course Photograph 
Preparation	None

Lesson 17

Materials	<p>Kit Items None</p> <p>School-Supplied Items <input type="checkbox"/> Notebooks, single-subject (2) <input type="checkbox"/> Pennies (180)</p> <p>Prepared Items from Previous Lessons <input type="checkbox"/> Atwood machines from Lesson 11 (6)</p> <p>Item Reuse <input type="checkbox"/> Lesson 19 requires 2 of the pennies.</p>
Resources	<input type="checkbox"/> Lesson 17 Resource: Notebook Demonstration Setup Instructions
Preparation	<input type="checkbox"/> Prepare notebooks for notebook demonstration. (See Lesson 17 Resource.)

Lesson 18

Materials	<p>Kit Items None</p> <p>School-Supplied Items None</p>
Resources	<input type="checkbox"/> Lesson 18 Resource: Conceptual Checkpoint 
Preparation	<input type="checkbox"/> Cue <ul style="list-style-type: none"> ○ “Calder: Hypermobility <i>Triple Gong</i>, c. 1948” video (Whitney Museum of American Art 2017) (http://phdsci.link/1398),  ○ “Astronauts Kicking a Soccer Ball” video (http://phdsci.link/1343),  ○ volleyball game video (http://phdsci.link/2477),  ○ underhand volleyball hit video (http://phdsci.link/2479),  ○ overhand volleyball hit video (http://phdsci.link/2478),  and ○ children playing with wooden figures video (http://phdsci.link/1400).  <input type="checkbox"/> Prepare to distribute a copy of Lesson 18 Resource to each student.


Lesson 19

Materials	<p>Kit Items</p> <ul style="list-style-type: none"><input type="checkbox"/> Aluminum foil, 4" × 4" (2)<input type="checkbox"/> Cloths, cotton, 6" × 6" (2)<input type="checkbox"/> Cork stoppers (2)<input type="checkbox"/> Magnets, bar, with N/S labels (2)<input type="checkbox"/> Magnets, ceramic ring (24)<input type="checkbox"/> Magnets, ceramic ring, coated (2)<input type="checkbox"/> Paper clips, large, metal (62)<input type="checkbox"/> Screws, brass (2)<input type="checkbox"/> Screws, steel (2)<input type="checkbox"/> Washers, brass (2)<input type="checkbox"/> Washers, steel (2) <p>Module 1 Kit</p> <ul style="list-style-type: none"><input type="checkbox"/> Clothespins, wooden, 3" (2)<input type="checkbox"/> Cups, plastic, 9 oz (3)<input type="checkbox"/> Magnets, bar, with N/S labels (6)<input type="checkbox"/> Timer, digital (1) <p>Module 2 Kit</p> <ul style="list-style-type: none"><input type="checkbox"/> Compasses, mini (4)<input type="checkbox"/> Ruler, metric (1) <p>School-Supplied Items</p> <ul style="list-style-type: none"><input type="checkbox"/> Book, thick (1)<input type="checkbox"/> Book, thin (1)<input type="checkbox"/> Construction paper, 12" × 18" (2 sheets)<input type="checkbox"/> Marker, permanent (1)<input type="checkbox"/> Paper, printer, 8.5" × 11" (1 sheet)<input type="checkbox"/> Paper towels (1 roll)<input type="checkbox"/> Pencils, regular or round (2)<input type="checkbox"/> Pennies (2)<input type="checkbox"/> Scissors (1)<input type="checkbox"/> Tape, masking (partial roll)<input type="checkbox"/> Water (6 oz) <p>Item Reuse</p> <ul style="list-style-type: none"><input type="checkbox"/> Lesson 20 requires the ceramic ring magnets and the prepared class magnet list.<input type="checkbox"/> Lesson 21 requires 1 of the paper clips.<input type="checkbox"/> Lesson 24 requires the paper clips, clothespins, and plastic cups. Consider saving the prepared plastic cups with clothespins and prepared hook paper clips for the magnet strength test in Lesson 24.<input type="checkbox"/> Lesson 26 requires the digital timer.
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Lesson 19 *continued*

Resources	<input type="checkbox"/> Lesson 19 Resource A: Magnet Stations Setup Instructions <input type="checkbox"/> Lesson 19 Resource B: Magnet Stations Procedure Sheets
Preparation	<input type="checkbox"/> Set up magnet stations. (See Lesson 19 Resources A and B.) Advance Preparation for Lesson 23 <input type="checkbox"/> 1–5 Days Before: Prepare materials for research. (See Lesson 23 Resource C.) If necessary, arrange for student access to computers or tablets.





Lesson 20

Materials	<p>Kit Items</p> <input type="checkbox"/> Cloth, wool, 6" × 6" (1) <input type="checkbox"/> Magnets, ceramic ring (24)
	<p>Module 1 Kit</p> <input type="checkbox"/> Balloon (1) <input type="checkbox"/> Balloon pump, handheld (1)
	<p>School-Supplied Items</p> <input type="checkbox"/> Glue stick (1) <input type="checkbox"/> Sink with running water (or foam cup filled with water and plastic basin) (1) <input type="checkbox"/> Scissors (1)
	<p>Prepared Items from Previous Lessons</p> <input type="checkbox"/> Class magnet list started in Lesson 19 (1)
	<p>Item Reuse</p> <input type="checkbox"/> Lesson 21 requires the balloon pump and the wool cloth.
Resources	<input type="checkbox"/> Lesson 20 Resource A: Investigation Questions <input type="checkbox"/> Lesson 20 Resource B: Bending Water Demonstration Setup Instructions and Procedure
Preparation	<input type="checkbox"/> Cue children playing with wooden figures video (http://phdsci.link/1400).  <input type="checkbox"/> Prepare chart paper with investigation questions. (See Lesson 20 Resource A.) <input type="checkbox"/> Set up and test bending water demonstration. (See Lesson 20 Resource B.)



Lesson 21

<p>Materials</p>	<p>Kit Items</p> <ul style="list-style-type: none"> <input type="checkbox"/> Cloths, wool, 6" × 6" (6) <input type="checkbox"/> Magnet, ceramic disc (1) <input type="checkbox"/> Paper clip, large, metal (1) <p>Module 1 Kit</p> <ul style="list-style-type: none"> <input type="checkbox"/> Balloons (6) <input type="checkbox"/> Balloon pump, handheld (1) <input type="checkbox"/> String (8') <p>Module 2 Kit</p> <ul style="list-style-type: none"> <input type="checkbox"/> Ruler (1) <p>School-Supplied Items</p> <ul style="list-style-type: none"> <input type="checkbox"/> Blocks, large, wooden, or books (6–10) <input type="checkbox"/> Desk (1) <input type="checkbox"/> Scissors (1) <input type="checkbox"/> Soda cans, empty (6) <input type="checkbox"/> Tape, masking (partial roll)
<p>Resources</p>	<ul style="list-style-type: none"> <input type="checkbox"/> Lesson 21 Resource A: Conceptual Checkpoint Setup Instructions <input type="checkbox"/> Lesson 21 Resource B: Conceptual Checkpoint  <input type="checkbox"/> Lesson 21 Resource C: Magnetic Wristband Photograph 
<p>Preparation</p>	<ul style="list-style-type: none"> <input type="checkbox"/> Inflate balloons for static soda can activity. Each group needs an inflated balloon. <input type="checkbox"/> Set up materials for Conceptual Checkpoint. (See Lesson 21 Resource A.) <input type="checkbox"/> Prepare to distribute a copy of Lesson 21 Resource B to each student. <input type="checkbox"/> Cue “Cooking in Space: Whole Red Rice and Turmeric Chicken” video (ESA 2015) (http://phdsci.link/2420). 

Lesson 22

Materials	<p>Kit Items None</p> <p>School-Supplied Items None</p>
Resources	<ul style="list-style-type: none"> <input type="checkbox"/> Lesson 22 Resource A: “So Repulsive, It’s Attractive!” (D’Alto 2009) <input type="checkbox"/> Lesson 22 Resource B: Maglev Train Image  <input type="checkbox"/> Lesson 22 Resource C: Uses of Magnets Texts
Preparation	<ul style="list-style-type: none"> <input type="checkbox"/> 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” (<i>SuperScience</i> 2018), and the other half should receive “Sportswear with Zip” (McCally 2014). <input type="checkbox"/> Cue <ul style="list-style-type: none"> <input type="checkbox"/> maglev train video (http://phdsci.link/1407),  <input type="checkbox"/> magnetic zipper video (http://phdsci.link/2431),  and <input type="checkbox"/> sideways elevator video (http://phdsci.link/1409). 

Lesson 23

Materials	<p>Kit Items</p> <ul style="list-style-type: none"> <input type="checkbox"/> Box, cardboard, 8" × 5" × 3", unassembled (1) <p>School-Supplied Items</p> <ul style="list-style-type: none"> <input type="checkbox"/> Scissors (1) <input type="checkbox"/> Whiteboards, personal (12, optional) <p>Item Reuse</p> <ul style="list-style-type: none"> <input type="checkbox"/> Lesson 24 requires the prepared cardboard box.
Resources	<ul style="list-style-type: none"> <input type="checkbox"/> Lesson 23 Resource A: Engineering Challenge Rubric <input type="checkbox"/> Lesson 23 Resource B: Engineering Design Process  <input type="checkbox"/> Lesson 23 Resource C: Research Mechanical Engineers <input type="checkbox"/> Lesson 23 Resource D: Cardboard Box Assembly Instructions
Preparation	<ul style="list-style-type: none"> <input type="checkbox"/> Cue “Raw Video: Tool Bag Lost During Space Walk” (http://phdsci.link/1410).  <input type="checkbox"/> Assemble a cardboard box for students to observe. (See Lesson 23 Resource D.)

Lesson 24

<p>Materials</p>	<p>Kit Items</p> <ul style="list-style-type: none"> <input type="checkbox"/> Boxes, cardboard, 8" × 5" × 3", unassembled (5) <input type="checkbox"/> Magnets, ceramic disc (6) <input type="checkbox"/> Magnets, square, adhesive-backed (6) <input type="checkbox"/> Paper clips, large, metal (156) <p>Module 1 Kit</p> <ul style="list-style-type: none"> <input type="checkbox"/> Clothespins, wooden, 3" (6) <input type="checkbox"/> Cups, plastic, 9 oz (6) <p>School-Supplied Items</p> <ul style="list-style-type: none"> <input type="checkbox"/> Scissors (1) <input type="checkbox"/> Tape, masking (partial roll) <p>Prepared Items from Previous Lessons</p> <ul style="list-style-type: none"> <input type="checkbox"/> Cardboard box from Lesson 23 (1) <p>Item Reuse</p> <ul style="list-style-type: none"> <input type="checkbox"/> Lesson 25 requires the assembled cardboard boxes and the ceramic disc magnets.
<p>Resources</p>	<ul style="list-style-type: none"> <input type="checkbox"/> Lesson 23 Resource D: Cardboard Box Assembly Instructions <input type="checkbox"/> Lesson 24 Resource A: Magnet Strength Test Setup Instructions <input type="checkbox"/> Lesson 24 Resource B: Magnet Strength Test Procedure Sheet
<p>Preparation</p>	<ul style="list-style-type: none"> <input type="checkbox"/> Prepare magnet strength test materials. (See Lesson 24 Resource A.) <input type="checkbox"/> Prepare to distribute a copy of Lesson 24 Resource B to each group. <input type="checkbox"/> Assemble a cardboard box for each group. (See Lesson 23 Resource D.)

Lesson 25

Materials	<p>Kit Items</p> <ul style="list-style-type: none"> <input type="checkbox"/> Baking sheet, magnetic metal (1) <input type="checkbox"/> Glue gun with glue sticks (1) <input type="checkbox"/> Magnets, ceramic disc (30) <input type="checkbox"/> Magnets, square, adhesive-backed (120) <input type="checkbox"/> Toy tools, plastic (24) <p>Module 1 Kit</p> <ul style="list-style-type: none"> <input type="checkbox"/> Safety goggles, student (24) <input type="checkbox"/> Safety goggles, teacher (1) <input type="checkbox"/> String (partial spool) <input type="checkbox"/> Timer, digital (1) <p>School-Supplied Items</p> <ul style="list-style-type: none"> <input type="checkbox"/> Tape, masking (6 rolls) <p>Prepared Items from Previous Lessons</p> <ul style="list-style-type: none"> <input type="checkbox"/> Assembled cardboard box from Lesson 24 (1) <p>Item Reuse</p> <ul style="list-style-type: none"> <input type="checkbox"/> Lesson 26 requires the baking sheet, glue gun with glue sticks, prepared Engineering Challenge materials, and digital timer.
Resources	<ul style="list-style-type: none"> <input type="checkbox"/> Lesson 25 Resource: Engineering Challenge Testing Procedure Sheets
Preparation	<ul style="list-style-type: none"> <input type="checkbox"/> Prepare to distribute a copy of Lesson 25 Resource to each group.

Lesson 26

Materials	<p>Kit Items</p> <ul style="list-style-type: none"> <input type="checkbox"/> Baking sheet, magnetic metal (1) <input type="checkbox"/> Glue gun with glue sticks (1) <p>Module 1 Kit</p> <ul style="list-style-type: none"> <input type="checkbox"/> Safety goggles, student (24) <input type="checkbox"/> Safety goggles, teacher (1) <input type="checkbox"/> Timer, digital (1) <p>School-Supplied Items</p> <p>None</p> <p>Prepared Items from Previous Lessons</p> <ul style="list-style-type: none"> <input type="checkbox"/> Engineering Challenge materials from Lesson 25 <p>Item Reuse</p> <ul style="list-style-type: none"> <input type="checkbox"/> Lesson 27 requires the prepared Engineering Challenge prototypes and glue gun with glue sticks.
Resources	<ul style="list-style-type: none"> <input type="checkbox"/> Lesson 25 Resource: Engineering Challenge Testing Procedure Sheets
Preparation	<p>None</p>




Lesson 27

Materials	<p>Kit Items</p> <input type="checkbox"/> Glue gun with glue sticks (1) <p>School-Supplied Items</p> <p>None</p> <p>Prepared Items from Previous Lessons</p> <input type="checkbox"/> Engineering Challenge prototypes from Lesson 26
Resources	None
Preparation	None

Lesson 28

Materials	<p>Kit Items</p> <p>None</p> <p>School-Supplied Items</p> <input type="checkbox"/> Glue sticks (24)
Resources	None
Preparation	None

Lesson 29

Materials	<p>Kit Items</p> <p>None</p> <p>School-Supplied Items</p> <p>None</p>
Resources	<input type="checkbox"/> Lesson 29 Resource: Sled Diagrams
Preparation	<input type="checkbox"/> Cue the child sledding video (http://phdsci.link/2505)  and dogsled video (http://phdsci.link/2506).  <input type="checkbox"/> Prepare to distribute a copy of the sled diagrams to each student. (See Lesson 29 Resource.) <input type="checkbox"/> Prepare to distribute a copy of the End-of-Module Assessment to each student. 

Lesson 30

Materials	Kit Items None School-Supplied Items None
Resources	<input type="checkbox"/> Lesson 30 Resource A: Module Concept Statements <input type="checkbox"/> Lesson 30 Resource B: Recurring Themes and Concepts <input type="checkbox"/> End-of-Module Assessment Rubric
Preparation	<input type="checkbox"/> Prepare to distribute a copy of the End-of-Module Assessment rubric to each student. <input type="checkbox"/> Score End-of-Module Assessments and write individual feedback. <input type="checkbox"/> Select End-of-Module Assessment responses to share with students for additional support. If selecting student responses, remember to remove identifying information and to choose diverse student responses. <input type="checkbox"/> Prepare visual for student connections between module learning and content standards. (See Lesson 30 Resources A and B.)


Solar System | Advance Preparation

One activity in these lessons requires advance preparation. A version of this list appears in the Spotlight Overview of the Teacher Edition. The expanded version in this guide identifies the lesson 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
2	1 day†	Temperature Investigation	Place a thermometer outside at about the same time of day and in the same location that students will collect their data. Test how long it takes for the thermometer to stabilize at a constant temperature, typically 15 to 20 minutes.

Solar System | Lesson Preparation





Lesson 1

Materials	<p>Kit Items None</p> <p>School-Supplied Items None</p>
Resources	None
Preparation	<p>Cue the solar eclipse over Mackay, Idaho, video (http://phdsci.link/1980) and total solar eclipse over Spray, Oregon, video (http://phdsci.link/1981). </p> <p>Advance Preparation for Lesson 2</p> <p><input type="checkbox"/> 1 Day Before: Place a thermometer outside at about the same time of day and in the same location that 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.</p>




Lesson 2

Materials	<p>Kit Items</p> <ul style="list-style-type: none"> <input type="checkbox"/> Cardboard, 12" x 12" (6) <p>Module 1 Kit</p> <ul style="list-style-type: none"> <input type="checkbox"/> Safety goggles, student (24) <input type="checkbox"/> Safety goggles, teacher (1) <input type="checkbox"/> Thermometer, Celsius (6) <input type="checkbox"/> Timers, digital (6) <p>School-Supplied Items</p> <ul style="list-style-type: none"> <input type="checkbox"/> Scissors (1) <input type="checkbox"/> Sunlight (access) <p>Item Reuse</p> <ul style="list-style-type: none"> <input type="checkbox"/> Lesson 4 requires the scissors.
Resources	<ul style="list-style-type: none"> <input type="checkbox"/> Lesson 2 Resource A: Temperature Investigation Procedure Sheet <input type="checkbox"/> Lesson 2 Resource B: Solar Eclipse Data <input type="checkbox"/> Lesson 2 Resource C: Line Graph Template 
Preparation	<ul style="list-style-type: none"> <input type="checkbox"/> 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. <input type="checkbox"/> Cut out a 12" cardboard circle for each group. <input type="checkbox"/> Prepare to distribute a copy of the temperature investigation procedure sheet to each group. (See Lesson 2 Resource A.)



Lesson 3

Materials	<p>Kit Items</p> <p>None</p> <p>School-Supplied Items</p> <p>None</p>
Resources	<ul style="list-style-type: none"> <input type="checkbox"/> Lesson 3 Resource A: Scientist Prepares to Record Sound Photograph  <input type="checkbox"/> Lesson 3 Resource B: Daytime Animals and Nighttime Animals  <input type="checkbox"/> Lesson 3 Resource C: Solar Eclipse Sound Observations
Preparation	<ul style="list-style-type: none"> <input type="checkbox"/> Cue the daytime animal sounds audio clip (http://phdsci.link/1982)  and nighttime animal sounds audio clip (http://phdsci.link/1983).  <input type="checkbox"/> Prepare to distribute a copy of the solar eclipse sound observations to each student pair. (See Lesson 3 Resource C.)

Lesson 4

<p>Materials</p>	<p>Kit Items</p> <ul style="list-style-type: none"> <input type="checkbox"/> Tape measure (1) <p>Module 1 Kit</p> <ul style="list-style-type: none"> <input type="checkbox"/> String (partial spool) <p>School-Supplied Items</p> <ul style="list-style-type: none"> <input type="checkbox"/> Card stock, 8.5" × 11" (8) <input type="checkbox"/> Scissors (1) <input type="checkbox"/> Tape, masking (partial roll) <p>Item Reuse</p> <ul style="list-style-type: none"> <input type="checkbox"/> Lesson 7 requires the tape measure.
<p>Resources</p>	<ul style="list-style-type: none"> <input type="checkbox"/> Lesson 4 Resource A: Star Photographs  <input type="checkbox"/> Lesson 4 Resource B: Alpha Centauri A Photograph  <input type="checkbox"/> Lesson 4 Resource C: Star Diagram  <input type="checkbox"/> Lesson 4 Resource D: Star Cutouts <input type="checkbox"/> Lesson 4 Resource E: Star Viewfinder Setup Instructions <input type="checkbox"/> Lesson 4 Resource F: Distance Measuring Tool Setup Instructions
<p>Preparation</p>	<ul style="list-style-type: none"> <input type="checkbox"/> Identify a space large enough for students to complete the distance investigation. <input type="checkbox"/> Prepare to distribute a copy of the star diagram to each student pair. (See Lesson 4 Resource C.) <input type="checkbox"/> Prepare star cutouts. (See Lesson 4 Resource D.) <input type="checkbox"/> Prepare star viewfinders. (See Lesson 4 Resource E.) <input type="checkbox"/> Prepare distance measuring tools. (See Lesson 4 Resource F.)


Lesson 5

Materials	<p>Kit Items</p> <ul style="list-style-type: none"> <input type="checkbox"/> Jars with lids, clear plastic, 4 oz (6) <p>Module 1 Kit</p> <ul style="list-style-type: none"> <input type="checkbox"/> Balloon pump, handheld (1) <input type="checkbox"/> Balloons (2) <input type="checkbox"/> Rock samples, granite (3) <input type="checkbox"/> Scales, digital (6) <p>School-Supplied Items</p> <ul style="list-style-type: none"> <input type="checkbox"/> Scissors (1) <input type="checkbox"/> Tape, masking (partial roll) <input type="checkbox"/> Water (access)
Resources	<ul style="list-style-type: none"> <input type="checkbox"/> Lesson 4 Resource C: Star Diagram  <input type="checkbox"/> Lesson 5 Resource A: Planet Cards <input type="checkbox"/> Lesson 5 Resource B: Matter Investigation Setup Instructions <input type="checkbox"/> Lesson 5 Resource C: Mercury and Venus Photographs 
Preparation	<ul style="list-style-type: none"> <input type="checkbox"/> Prepare to distribute planet cards to each group. (See Lesson 5 Resource A.) <input type="checkbox"/> Prepare materials for matter investigation. (See Lesson 5 Resource B.) <input type="checkbox"/> Use a balloon pump to inflate a balloon.



Lesson 6

Materials	<p>Kit Items</p> <ul style="list-style-type: none"> <input type="checkbox"/> Balls, polystyrene foam, 1" (6) <input type="checkbox"/> Balls, polystyrene foam, 3" (6) <input type="checkbox"/> Clay, modeling, nonhardening (1 ½ lb) <input type="checkbox"/> Dowels, wooden (12) <p>Module 1 Kit</p> <ul style="list-style-type: none"> <input type="checkbox"/> Cups, plastic, 9 oz (6) <p>School-Supplied Items</p> <ul style="list-style-type: none"> <input type="checkbox"/> Basketballs or other spherical objects of similar size (6) <input type="checkbox"/> Scissors (1)
Resources	<ul style="list-style-type: none"> <input type="checkbox"/> Lesson 5 Resource A: Planet Cards <input type="checkbox"/> Lesson 6 Resource: Sun and Moon Cards
Preparation	<ul style="list-style-type: none"> <input type="checkbox"/> Prepare to distribute Sun and moon cards to each student pair. (See Lesson 6 Resource.) <input type="checkbox"/> Prepare to distribute Earth cards to each student pair. (See Lesson 5 Resource A.)


Lesson 7

Materials	<p>Kit Items</p> <ul style="list-style-type: none"> <input type="checkbox"/> Tape measure (1) <p>School-Supplied Items</p> <ul style="list-style-type: none"> <input type="checkbox"/> Chart paper, at least 60 cm wide (6 sheets) <input type="checkbox"/> Paper, colored, 8.5" × 11" (1 sheet) <input type="checkbox"/> Scissors (1) <input type="checkbox"/> Tape, masking (partial roll)
Resources	<ul style="list-style-type: none"> <input type="checkbox"/> Lesson 5 Resource A: Planet Cards <input type="checkbox"/> Lesson 6 Resource: Sun and Moon Cards <input type="checkbox"/> Lesson 7 Resource A: Sun and Moon Investigation Setup <input type="checkbox"/> Lesson 7 Resource B: Solar Eclipse Photograph 
Preparation	<ul style="list-style-type: none"> <input type="checkbox"/> Prepare materials for Sun and moon investigation. (See Lesson 7 Resource A.) Before the lesson, identify a large area to set up this investigation.

Lesson 8

Materials	<p>Kit Items</p> <p>None</p> <p>School-Supplied Items</p> <ul style="list-style-type: none"> <input type="checkbox"/> Glue sticks (24) <input type="checkbox"/> Scissors (24)
Resources	<ul style="list-style-type: none"> <input type="checkbox"/> Lesson 8 Resource: Planetary Alignment Photograph 
Preparation	<ul style="list-style-type: none"> <input type="checkbox"/> Cue the rocket launch video (http://phdsci.link/2570).  <input type="checkbox"/> Prepare to distribute a copy of the End-of-Spotlight Assessment to each student.

Lesson 9

Materials	Kit Items None School-Supplied Items None
Resources	<input type="checkbox"/> Lesson 9 Resource A: Content Standards <input type="checkbox"/> Lesson 9 Resource B: Recurring Themes and Concepts <input type="checkbox"/> End-of-Spotlight Assessment Rubric 
Preparation	<input type="checkbox"/> Prepare to distribute a copy of the End-of-Spotlight Assessment rubric to each student. <input type="checkbox"/> Score End-of-Spotlight Assessments and write individual feedback. <input type="checkbox"/> Select End-of-Spotlight Assessment responses to share with students for additional support. If selecting student responses, remember to remove identifying information and to choose diverse student responses. <input type="checkbox"/> Prepare visual for student connections between content standards and Recurring Themes and Concepts. (See Lesson 9 Resources A and B.)

Forces and Motion | Works Cited

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