Preparation Guide

Level 4 Module 1

Energy with Spotlight Lessons on Matter

Materials: This section lists the quantity of each material necessary for the lesson. Lesson materials may be from a *PhD Science*® 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.

Preparation: This section identifies preparation teachers should complete before the lesson, including resources teachers should gather or cue. This section has two subsections:

- **Resources:** This subsection 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.
- **Setup:** This subsection lists media teachers must cue before the lesson, activities that require setup, and 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. This subsection also describes advance preparation for upcoming lessons. For example, if teachers need to prepare one day in advance for an activity in Lesson 11, an advance preparation note appears in the Setup subsection 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
12	1 day†	Model Energy Transformations	Make or obtain 5 cups of ice for Station 3a before Lesson 12.
13	1 day†	Model Energy Transformations	Make or obtain 5 cups of ice for Station 3a before Lesson 13.

Energy Lesson Materials and Preparation

Lesson 1

<table>
<tr><td>Materials</td><td>Kit Items
None</td><td>School Supplied Items
☐ Pencils (24)
☐ Plates, paper (24)
☐ Pushpins (24)
☐ Scissors, blunt tip (24)</td></tr>
<tr><td rowspan="2">Preparation</td><td colspan="2">Resources
☐ Lesson 1 Resource A: Windmill Gears Photograph
☐ Lesson 1 Resource B: Windmill Grinding Photograph</td></tr>
<tr><td colspan="2">Setup
☐ Open Windmill, 1917 by Piet Mondrian: http://phdsci.link/1017.
☐ Open Oostzijdse Mill with Extended Blue, Yellow, and Purple Sky, 1907–08 by Piet Mondrian: http://phdsci.link/1018.
☐ Cue “Windmill Gears” video (andy b 2008): http://phdsci.link/1019.

Item Reuse
☐ Lesson 22 requires 6 of the pinwheels created by students.</td></tr>
</table>

Lesson 2

<table>
<tr><td>Materials</td><td>Kit Items
☐ Snap Circuits® Green kits by Elenco®
☐ Base grids, 10” × 12” (6)
☐ Jumper wires, black, red (6 each)
☐ LEDs, red (6)
☐ Motors (6)
☐ Pivot posts, stand bases, tops (6 each)
☐ Wind fans (6)</td><td>School Supplied Items
None</td></tr>
<tr><td rowspan="2">Preparation</td><td colspan="2">Resources
☐ Lesson 2 Resource: Windmill Model Setup Instructions
☐ The Boy Who Harnessed the Wind: Creating Currents of Electricity and Hope by William Kamkwamba and Bryan Mealer (2010)</td></tr>
<tr><td colspan="2">Setup
☐ Open maps of Africa and Malawi: http://phdsci.link/1158.

Item Reuse
☐ Lesson 4 requires 2 prepared Snap Circuits® windmills.</td></tr>
</table>

Lesson 3

<table>
<tr><td>Materials</td><td>Kit Items
None</td><td>School Supplied Items
None</td></tr>
<tr><td rowspan="2">Preparation</td><td colspan="2">Resources
☐ Lesson 3 Resource A: Modern Wind Turbine Photograph
☐ Lesson 3 Resource B: Wind Farm Photograph
☐ Lesson 3 Resource C: Wind Farm Diagram</td></tr>
<tr><td colspan="2">Setup
None</td></tr>
</table>

Lesson 4

<table>
<tr><td rowspan="2">Materials</td><td>Kit Items
☐ Batteries, AAA (4)
☐ Blocks, wooden (2)
☐ Flashlights, hand-crank (2)
☐ Heat lamps (2)
☐ Radios, handheld (2)
☐ Sandpaper, 4”× 5” (2)
☐ Toy cars, pull back (2)</td><td>School Supplied Items
None</td></tr>
<tr><td colspan="2">Prepared Items from Previous Lessons
☐ Snap Circuits® windmills from Lesson 2 (2)</td></tr>
<tr><td rowspan="2">Preparation</td><td colspan="2">Resources
None</td></tr>
<tr><td colspan="2">Setup
☐ Set up energy stations.

Item Reuse
☐ Lesson 5 requires the prepared energy stations.
☐ Lesson 6 requires the prepared Snap Circuits® windmills.
☐ Lesson 12 requires the heat lamps.</td></tr>
</table>

Lesson 5

<table>
<tr><td rowspan="2">Materials</td><td>Kit Items
None</td><td>School Supplied Items
☐ Sentence strips (15)</td></tr>
<tr><td colspan="2">Prepared Items from Previous Lessons
☐ Energy stations from Lesson 4 (6)</td></tr>
<tr><td rowspan="2">Preparation</td><td colspan="2">Resources
None</td></tr>
<tr><td colspan="2">Setup
☐ Set up energy stations.

Item Reuse
☐ Lesson 6 requires the toy cars.</td></tr>
</table>

Lesson 6

<table>
<tr><td rowspan="2">Materials</td><td>Kit Items
☐ Toy cars, pull back (2)</td><td>School Supplied Items
☐ Balls (e.g., soccer balls, kickballs) or other class-suggested objects (2)</td></tr>
<tr><td colspan="2">Prepared Items from Previous Lessons
☐ Snap Circuits® windmills from Lesson 2 (2)</td></tr>
<tr><td rowspan="2">Preparation</td><td colspan="2">Resources
None</td></tr>
<tr><td colspan="2">Setup
None</td></tr>
</table>

Lesson 7

<table>
<tr><td rowspan="2">Materials</td><td>Kit Items
☐ Bearing balls, 1” (6)
☐ Rulers, grooved (6)
☐ Stopwatches (6)</td><td>School Supplied Items
☐ Meter sticks (6)
☐ Tape, masking (partial roll)
☐ Textbooks, matching, at least 1” thick (6)</td></tr>
<tr><td colspan="2">Resources
None</td></tr>
<tr><td rowspan="2">Preparation</td><td colspan="2">Setup
☐ Ensure that all stopwatches work properly.

Item Reuse
☐ Lesson 8 requires the bearing balls, meter sticks, grooved rulers, and textbooks.</td></tr>
</table>

Lesson 8

Materials	**Kit Items** ☐ Bearing balls, 1" (6) ☐ Catches, ball bearing (6) ☐ Rulers, grooved (12) ☐ Safety goggles (24)	**School Supplied Items** ☐ Meter sticks (6) ☐ Tape, masking (partial roll) ☐ Textbooks, matching, at least 1" thick (6)
Preparation	**Resources** None	
	Setup None	

Lesson 9

No materials or preparation required.

Lesson 10

Materials	**Kit Items** ☐ Blocks, wooden, 3 cm x 5 cm x 1.5 cm (6) ☐ Burlap 12" x 24"Grass, artificial, 12" x 24" (6) ☐ Marbles, 5/8"(6) ☐ Padding, foam rubber, 12" x 24" (6) ☐ Rulers, grooved (6) ☐ Safety goggles (24)	**School Supplied Items** ☐ Meter sticks (6) ☐ Tape (partial roll)
Preparation	**Resources** None	
	Setup ☐ Cue Frustration at the Postage Stamp" video (Golf Channel 2016): http://phdsci.link/1396 and http://phdsci.link/1397 .	

Lesson 11

Materials	Kit Items None	School Supplied Items None
Preparation	**Resources** ☐ Lesson 11 Resource: Golf Course Photograph	
	Setup None **Advance Preparation for Lesson 12** **1 Day Before:** Make or obtain 5 cups of ice for Station 3a before Lesson 12.	

Lesson 12

Materials	Kit Items	School Supplied Items
	☐ Heat Lamps (2) ☐ Radiometer (1) ☐ Snap Circuits® Green kit ☐ Horn (1) ☐ Jumper wires, black, red (1 each) ☐ Solar cell (1) ☐ Speaker (1, optional) ☐ Thermometers, Fahrenheit (2)	☐ Balloons, high quality, large (24) ☐ Binder clips, small (2) ☐ Bowls, large, about 1 qt (2) ☐ Computer with USB port (1, optional) ☐ Cups, clear plastic, 9 oz (6) ☐ Flashlights (2) or construction paper, black (2 sheets) ☐ Ice (5 cups) ☐ Plastic wrap (1 roll) ☐ Rice, dry (1 tbsp) ☐ Rubber band (1) **Optional Energy Transformation Extension Materials** ☐ Alcohol pads (24) ☐ Aluminum foil (1 roll) ☐ Construction paper, black (2 sheets) ☐ Kazoos (2) ☐ Newspaper (12 sheets) ☐ Pencil (1) ☐ Pizza box (1) ☐ Plastic wrap (1 roll) ☐ Rubber bands, large, varying lengths (4) ☐ Ruler or wooden spoon (1) ☐ Shoebox (1) ☐ Tape, clear (1 roll)

		☐ Tuning fork (1) ☐ Utility knife or scissors (1)
Preparation	**Resources** ☐ Lesson 12 Resource A: Energy Transformation Station Setup Instructions ☐ Lesson 12 Resource B: Energy Transformation Station Procedure Sheets ☐ Lesson 12 Resource C: Extension: Energy Transformation Station Setup Instructions ☐ Lesson 12 Resource D: Extension: Energy Transformation Station Guidance ☐ Lesson 12 Resource E: Extension: Energy Transformation Station Procedure Sheets ☐ Lesson 12 Resource F: Extension: Energy Transformation Observations	
	Setup ☐ Cut paper towel tubes into thirds. ☐ Cut out and display Energy Transformation Station Procedure Sheets at each station. **Item Reuse** ☐ Lesson 13 requires the prepared energy transformation station materials and, if used in Lesson 12, the optional energy transformation station extension materials. **Advance Preparation for Lesson 13** **1 Day Before:** Make or obtain 5 cups of ice for Station 3a before Lesson 13.	

Lesson 13

Materials	**Kit Items** None	**School Supplied Items** None
	Prepared Items from Previous Lessons ☐ Prepared Energy Transformation extension materials from Lesson 12 (optional) ☐ Prepared Energy Transformation Station materials from Lesson 12	
Preparation	**Resources** None	
	Setup ☐ Cut paper towel tubes into thirds. ☐ Cut out and display Energy Transformation Station Procedure Sheets at each station.	

Lesson 14

<table>
<tr><td>Materials</td><td>Kit Items
☐ Batteries, D (6)
☐ Lightbulbs, incandescent, miniature (6)
☐ Snap Circuits® Green kit
☐ Base grids, 10’ x 12” (1)
☐ Jumper wires, black, red (1 each)
☐ LED, red (1)
☐ Motor (1)
☐ Pivot post, stand base, top (1 each)
☐ Wind fan (1)
☐ Tape, electrical (6 rolls)</td><td>School Supplied Items
☐ Aluminum foil (partial roll)
☐ Scissors, blunt tip (6)</td></tr>
<tr><td rowspan="2">Preparation</td><td colspan="2">Resources
☐ Lesson 14 Resource: Electrical Circuit Setup Instructions and Procedure</td></tr>
<tr><td colspan="2">Setup
☐ Prepare aluminum foil strips. (See Lesson 14 Resource.)</td></tr>
</table>

Lesson 15

<table>
<tr><td>Materials</td><td>Kit Items
☐ Batteries, D (6)
☐ Clay, modeling, nonhardening (3 oz)
☐ Craft sticks, jumbo (6)
☐ Light bulbs, incandescent, miniature (7)
☐ Paper clips, metal (6)
☐ Tape, electrical (6 rolls)</td><td>School Supplied Items
☐ Aluminum foil (partial roll)
☐ Coins (6)
☐ Scissors, blunt tip (6)
☐ String, 9” (2)
☐ Steel wool (3 oz)</td></tr>
<tr><td rowspan="2">Preparation</td><td colspan="2">Resources
☐ Lesson 15 Resource: Thermal Conductors and Insulators Photographs</td></tr>
<tr><td colspan="2">Setup
☐ Rebuild groups’ circuits according to the instructions in Lesson 14 Resource, but skip step 3 (i.e., do not tape an aluminum foil strip to the light bulb’s metal base).
☐ Build a modified circuit according to the instructions in Lesson 14 Resource, but use pieces of string in place of aluminum foil strips.</td></tr>
</table>

Lesson 16

Materials	**Kit Items** None	**School Supplied Items** None
Preparation	**Resources** ☐ Lesson 16 Resource: Generator Photograph	
	Setup None	

Lesson 17

Materials	**Kit Items** ☐ Alligator clip cords (12) ☐ Copper wire, enamel coated, 32 m spool (6) ☐ LEDs (6) ☐ Magnets, neodymium (24) ☐ Nails, 4″ (6) ☐ Nuts, steel (12) ☐ Rulers, grooved (6) ☐ Safety goggles (24) ☐ Sandpaper, 4″ × 5″ (6) ☐ Wire cutter (1)	**School Supplied Items** ☐ Paper towel tubes (2) or toilet paper tubes (6)
Preparation	**Resources** None	
	Setup ☐ Cut paper towel tubes into thirds. **Item Reuse** ☐ Lesson 18 requires the prepared generator building materials. ☐ Lesson 22 requires the alligator clip cords.	

Lesson 18

Materials	**Kit Items** **None**	**School Supplied Items** None
	Prepared Items from Previous Lessons ☐ Prepared generator building materials from Lesson 17	
Preparation	**Resources** None	
	Setup None **Item Reuse** ☐ Lesson 22 requires the cardboard generators created by students.	

Lesson 19

Materials	**Kit Items** None	**School Supplied Items** None
Preparation	**Resources** ☐ Lesson 19 Resource: Hoover Dam Turbines Photograph	
	Setup None	

Lesson 20

Materials	**Kit Items** None	**School Supplied Items** None
	Resources None	
Preparation	**Setup** None **Item Reuse** Lesson 21 requires the prepared Engineering Challenge materials.	

Lesson 21

<table>
<tr><td>Materials</td><td>Kit Items
None</td><td>School Supplied Items
None</td></tr>
<tr><td rowspan="2">Preparation</td><td colspan="2">Resources
☐ Lesson 21 Resource: Engineering Design Process</td></tr>
<tr><td colspan="2">Setup
None</td></tr>
</table>

Lesson 22

<table>
<tr><td rowspan="2">Materials</td><td>Kit Items
☐ Alligator clip cords (12)
☐ LEDs (12)</td><td>School Supplied Items
None

Supplies Students May Bring from Home
☐ Bottles, plastic
☐ Craft sticks
☐ Cups, plastic or polystyrene
☐ Paper towel rolls
☐ Plates, plastic or paper
☐ Skewers, wooden
☐ Straws, plastic</td></tr>
<tr><td colspan="2">Prepared Items from Previous Lessons
☐ Cardboard generators from Lesson 18 (6)
☐ Pinwheels from Lesson 1 (6)</td></tr>
<tr><td rowspan="2">Preparation</td><td colspan="2">Resources
None</td></tr>
<tr><td colspan="2">Setup
None

Item Reuse
☐ Lesson 23 requires the prepared Engineering Challenge materials.</td></tr>
</table>

Lesson 23

Materials	**Kit Items** None	**School Supplied Items** None
	Prepared Items from Previous Lessons ☐ Engineering Challenge materials from Lesson 22	
Preparation	**Resources** None	
	Setup None **Item Reuse** ☐ Lesson 24 requires the prepared Engineering Challenge materials.	

Lesson 24

Materials	**Kit Items** None	**School Supplied Items** None
	Prepared Items from Previous Lessons ☐ Engineering Challenge materials from Lesson 22	
Preparation	**Resources** None	
	Setup None **Item Reuse** ☐ Lesson 25 requires the prepared Engineering Challenge materials.	

Lesson 25

Materials	**Kit Items** None	**School Supplied Items** None
	Prepared Items from Previous Lessons ☐ Engineering Challenge materials from Lesson 22	
Preparation	**Resources** None	
	Setup None **Item Reuse** ☐ Lesson 26 requires the prepared Engineering Challenge materials.	

Lesson 26

Materials	**Kit Items** None	**School Supplied Items** **None**
	Prepared Items from Previous Lessons ☐ Engineering Challenge materials from Lesson 22	
Preparation	**Resources** None	
	Setup None **Item Reuse** ☐ Lesson 27 requires the prepared Engineering Challenge materials.	

Lesson 27

Materials	**Kit Items** None	**School Supplied Items** None
	Prepared Items from Previous Lessons ☐ Engineering Challenge materials from Lesson 22	
Preparation	**Resources** None	
	Setup None	

Lesson 28

No materials or preparation required.

Lesson 29

No materials or preparation required.

Lesson 30

<table>
<tr><td>Materials</td><td>Kit Items
None</td><td>School Supplied Items
None</td></tr>
<tr><td rowspan="2">Preparation</td><td colspan="2">Resources
☐ Lesson 30 Resource: Content Standards</td></tr>
<tr><td colspan="2">Setup
☐ 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).</td></tr>
</table>

Matter Lesson Materials and Preparation

Lesson 1

<table>
<tr><td>Materials</td><td colspan="2">Kit Items
☐ Clay, modeling, nonhardening (1 lb)
☐ Container, clear plastic, round,16 oz (1)
☐ Dice (6)
☐ Jars with lids, clear plastic, 4 oz (12)
☐ Keys, brass (6)
☐ Magnets, bar (1)
☐ Magnets, ceramic disk (6)
☐ Marbles, 5/8 « (6)
☐ Safety goggles (24)
☐ Scales, digital, ± 0.1 g (1)
☐ Screws, steel (6)
☐ Washers, steel (6)</td><td>School Supplied Items
☐ Bags, resealable plastic, 1 qt (6)
☐ Crayons, blue or green (6)
☐ Dime (1)
☐ Dishwashing soap, liquid (12 fl oz)
☐ Erasers, wedge (6)
☐ Paper clip (1)
☐ Paper, 11” × 17” or larger (6 sheets)
☐ Penny (1)
☐ Rocks, small (6)
☐ Ruler (1)
☐ Scissors (1)
☐ Water, access</td></tr>
<tr><td rowspan="2">Preparation</td><td colspan="2">Resources
None</td></tr>
<tr><td colspan="2">Setup
☐ Mystery object demonstration: dime (1), paper clip (1), penny (1), ruler (1), scissors (1)
☐ Liquid and gas samples (1 set per group): 4 oz clear plastic jars with lids (2), liquid dishwashing soap (2 fl oz)
☐ Measuring properties discussion: 16 oz clear plastic container (1), bar magnet (1), digital scale (1), ruler (1), access to water

Item Reuse
☐ Lesson 2 requires prepared sets of objects from Lesson 1.</td></tr>
</table>

Lesson 2

<table>
<tr><td>Materials</td><td>Kit Items
☐ Ball, table tennis (1)
☐ Ball, tennis (1)
☐ Containers, clear plastic, round, 16 oz (1)
☐ Die (1)
☐ Graduated cylinders, 100 mL (6)
☐ Magnets, bar (6)
☐ Safety goggles (24)
☐ Scales, digital, ± 0.1 g (6)

Prepared Items from Previous Lessons
☐ Prepared sets of objects from Lesson 1 (6)</td><td>School Supplied Items
☐ Cups, 4 oz (12)
☐ Paper towels, partial roll
☐ Water, access</td></tr>
<tr><td rowspan="2">Preparation</td><td colspan="2">Resources
None</td></tr>
<tr><td colspan="2">Setup
☐ Ball discussion: table tennis ball (1), tennis ball (1)
☐ Measuring volume demonstration: 100 mL graduated cylinder (1), die (1), water (20 mL))

Item Reuse
☐ Lesson 3 requires prepared sets of objects from Lesson 1.</td></tr>
</table>

Lesson 3

<table>
<tr><td>Materials</td><td>Kit Items
☐ Containers, clear plastic, round, 16 oz (2)
☐ Graduated cylinders, 100 mL (2)
☐ Keys, brass (6)
☐ Magnets, bar (2)
☐ Safety goggles (24)
☐ Scales, digital, ± 0.1 g (1)

Prepared Items from Previous Lessons
☐ Prepared sets of objects from Lesson 1 (6)</td><td>School Supplied Items
☐ Cups, 4 oz (12)
☐ Erasers, wedge (60
☐ Paper towels, partial roll
☐ Rulers (2)
☐ Water, access</td></tr>
<tr><td rowspan="2">Preparation</td><td colspan="2">Resources
☐ Lesson 3 Resource A: Object Comparison Stations Setup Instructions
☐ Lesson 3 Resource B: Measurement Stations Procedure Sheets</td></tr>
<tr><td colspan="2">Setup
☐ Measuring Mass Station (2 per class): 4 oz cup (1), digital scale (1), procedure sheet (2).
☐ Measuring Volume Station (2 per class): 4 oz plastic cup (1), 16 oz plastic container (1), 100 mL graduated cylinder (1), procedure sheet (2), paper towels, access to water.
☐ Measuring Size and Observing Magnetism Station (2 per class): bar magnet (1), ruler (1), procedure sheet (1)</td></tr>
</table>

Lesson 4

<table>
<tr><td>Materials</td><td>Kit Items
☐ Beaker, glass, 250 mL (1)
☐ Cooling pad (1)
☐ Graduated cylinder, 100 mL (1)
☐ Hot plate (1)
☐ Safety goggles (24)
☐ Scales, digital, ± 0.1 g (1)
☐ Tongs, utility (1)</td><td>School Supplied Items
☐ Black pepper, ground (300 g)
☐ Cups, clear plastic, 9 oz (60)
☐ Marker, permanent (1)
☐ Salt (335 g)
☐ Spoons, plastic (36)
☐ Vegetable oil (1.2 L)
☐ Water (1.4 L)</td></tr>
<tr><td rowspan="2">Preparation</td><td colspan="2">Resources
☐ Lesson 4 Resource: Trail Mix Photograph</td></tr>
<tr><td colspan="2">Setup
☐ Prepare four samples for the exploring mixtures investigation (1 set per group). Use the graduated cylinder to measure 200 mL of vegetable oil and 200 mL of water into separate plastic cups. Then weigh 50 g of ground black pepper and 50 g of salt, and add each sample to a separate plastic cup. Label each cup with the sample name.</td></tr>
</table>

	☐ Prepare the separated saltwater mixture for display. Measure 35 g of salt and 200 mL of water into a beaker. Stir to dissolve the salt. Use the hot plate to boil the saltwater until salt crystals are visible on the bottom and sides of the beaker.

Lesson 5

Materials	**Kit Items** ☐ Graduated cylinder, 100 mL (6) ☐ Gravel (300 g) ☐ Sand, coarse (300 g) ☐ Scales, digital, ± 0.1 g (1) ☐ Safety goggles (24)	**School Supplied Items** ☐ Black pepper, ground 50 g) ☐ Cups, clear plastic, 9 oz (62) ☐ Marker, permanent (1) ☐ Salt (50 g) ☐ Spoons, plastic (50) ☐ Sugar (300 g) ☐ Vegetable oil (600 mL) ☐ Vinegar (600 mL) ☐ Water (1.6 L)
Preparation	**Resources** ☐ Lesson 5 Resource: Mixture Cards	
	Setup ☐ Prepare to distribute a mixture card to each group. (See Lesson 5 Resource.) ☐ Prepare samples for the making mixtures investigation (1 set per group). Use the graduated cylinder to measure 100 mL of vegetable oil, 100 mL of vinegar, and 100 mL of water into separate plastic cups. Use the digital scale to weigh 50 g of gravel, 50 g of sand, and 50 g of sugar, and add each sample to a separate plastic cup. Label each cup with the sample name.	

Works Cited

Andy b. 2008. “Windmill Gears.” YouTube video, 0:13, posted March 30, 2008, https://www.youtube.com/watch?v=gj5R_M7J4Iw.

Kamkwamba, William, and Bryan Mealer. 2010. *The Boy Who Harnessed the Wind: Creating Currents of Electricity and Hope*. New York: HarperCollins. [All references to *The Boy Who Harnessed the Wind* are from this source.]

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