



Standards (3rd grade up to High School) and Topic Connections:

<u>One Planet Topic</u>	Standards: <u>Next Generation Science</u>	<u>Environmental Principles and Concepts (EP&Cs)</u>
Consumption and Waste	<p>Performance Expectations (PE): Science and Engineering Practices (SEP) Disciplinary Core Ideas (DCI) and Crosscutting Concepts (CC)</p>	Principle IV
	<p>Elementary School (Grade 3-5): <u>3-5-ETS1-2 Engineering Design</u>: Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.</p> <p><u>4-ESS3-1. Earth and Human Activity</u>: Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.</p> <p><u>5-ESS3-1. Earth and Human Activity</u>: Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.</p> <p>Middle School (Grade 6 – Grade 8): <u>MS-LS2. Ecosystems: Interactions, Energy, and Dynamics</u>; Go to this link for a complete description.</p> <p><u>MS-ESS3. Earth and Human Activity</u>: Go to this link for a complete description.</p> <p>High School (Grade 9 – Grade 12): <u>HS-LS2. Ecosystems: Interactions, Energy, and Dynamics</u>: Go to this link for a complete description.</p> <p><u>HS-ESS3: Earth and Human Activity</u>; Go to this link for a complete description.</p>	 <p>The exchange of matter between natural systems and human societies affects the long-term functioning of both.</p>

This lesson can also be integrated into the **California State English Language Development Standards:** Grades 6-12 fitting into the Emerging, Expanding, and Bridging English Language Level Continuum.

- 1) Part 1 (Interacting in Meaningful Ways), A. 1
- 2) Part 1, A.3
- 3) Part 1, B.5
- 4) Part 1, C.10

Refer to www.cde.ca.gov/sp/el/er/eldstandards.asp, for the complete list and description of the California English Language Development Standards.

Learning Objectives:

The students will be able to:

- Explain and model the process of recycling, commercial composting, and of disposing of waste after materials get picked up from homes, businesses, and schools by the haulers.
- Name various items that can be landfilled, composted or recycled.
- Identify the raw materials that make glass, paper, plastic, and metal.
- Name various items that are made from recycled glass, paper, plastic, and metal.
- Describe the various environmental benefits of practicing the 4R's (reduce, reuse, recycle and rot/compost)

Essential Questions:

1. What happens in a system when resources are limited?
2. How do systems and changes in systems affect you?
3. How do our choices affect us, the community and the world?

Lesson Vocabulary:

Waste	Waste is defined as any item which is discarded after its primary use, or is deemed worthless, defective or of no use.
Garbage	Garbage is defined as waste that is sent to a landfill and items that never break down or will be used again.
Compost	Compost is defined as waste that is made of organic material that can be added to soil to help plants grow. Examples: Yard trimmings and food scraps.
Recycle	Recycling is defined as waste items that can be melted down and reformed into new items of the same material. Examples: Plastic items and metal items.
Rot	Rot is defined as the process in which organic waste items (compost) are breaking down into the basic nutrients soil needs to make plants grow.
Environment	The air, water, soil, minerals, organisms, and all other factors surrounding an organism.
Raw Materials	Raw materials are defined as the basic materials that are used to produce goods, finished products, energy, or intermediate products that are needed for finished products. Examples:
Natural Resources	Materials or substances such as minerals, forests, water, and fertile land that occur in nature and can be used for economic gain. Examples of natural resources: water, air, coal, oil, natural gas, phosphorus, iron, other minerals.
Renewable Resource	A renewable resource is a natural resource which will replenish to replace the depleted portion by consumption or usage. Examples: forests of trees grow back over time but cannot always keep up with the level of consumption by the human race.
Non-renewable Resource	A non-renewable resource is a natural resource that does not replenish to replace the depleted portion after consumption or usage.

Additional Vocabulary to review with students depending on age group and background

Organics	Any waste material that is biodegradable and comes from either a plant or an animal.
Landfill	A site or location also known as a dump or garbage dump that is a place for the disposal of waste

	materials.
Transfer Station	A transfer station is a building or processing site for the temporary deposition of waste. Garbage and organics are dropped off at the transfer station before they go to a landfill or commercial composting facility.
Transfer Truck	The semi truck used to move items from the transfer station to a landfill or commercial compost facility.
Material Recovery Facility	This facility receives, separates, sorts, and prepares recyclables to be sold to an end buyer. This facility uses a combination of equipment, machines and people power to separate and prepare materials to be recycled.
Hauler	The company that picks up the recyclables, organics, and garbage from homes, businesses, and schools.
Commercial Compost Facility	This is where organics are eventually brought to after being picked up by the hauler. The organics are put into large compost piles referred to as windrows, and with the help of fungus, bacteria, and invertebrates organics are broken down into compost.
Leachate	The “garbage juice” that is produced as water goes through the waste at a landfill. The leachate is pumped out of the landfill and captured, to protect the groundwater. Leachate is waste water.
Methane Gas	Methane gas is a portion of the natural gas that results from the breaking down of organic materials in a landfill, an anaerobic environment. This methane gas is a greenhouse gas that can be extremely harmful for the environment. It has a global warming potential of 21 to 23 times greater than CO ₂ .

Materials / Technology:

- A copy of the physical board games depending if game is taken home or played in school:
 - Game 1 (two boards: one board for take home and the other for in class)
 - Game 2 (two boards: one board divided up into four sections for take home and the other board for in class)
 - Game 3 (one board available for in class)
- Game cards associated with each games

Agenda / Activities:

	Pre-Lesson Activity	
Engage and Evaluate	Time:	20 minutes
	Directions for Activity 1 (Pre-Lesson Assessment):	<ul style="list-style-type: none"> ● Approximately a week before the lesson (4R's Games) teachers will have students read the five scenarios linked here and answer corresponding questions in their notebook or on the student worksheet questionnaire. ● Students are given a pre-lesson assessment worksheet with questions and scenarios meant to highlight what they already know about the 4R's ● Students should do this activity individually ● This activity can also lead to a post-assessment to evaluate knowledge gained by students after the lesson is completed.

Engage	Time:	10 minutes
	Direction for Activity 2 (Pre-Lesson Activity):	<ul style="list-style-type: none"> The teacher will have students write down the following questions in their notebook: <ol style="list-style-type: none"> What happens to garbage after it gets picked up from our homes and schools? <i>The garbage is brought to the transfer station where it is consolidated with other garbage. It is then brought to the landfill where it gets buried forever in the landfill.</i> What happens to recyclables after they are picked up from our homes? <i>Recyclables are brought to the material recovery facility where all the recyclables are separated from one another and consolidated. Recyclables such as aluminum cans are brought to a factory / manufacturer where they are made into new products.</i> What happens to green waste or compostables (organics) after they get picked up from our homes? <i>The green waste or compostables are brought to the transfer station where they are consolidated with other organics. They are then brought to a commercial composting facility where the organics break down into compost.</i> The teacher will play a video clips showing how a transfer station and material recovery facility work. The following video clips can be used for this activity or the teacher may choose to use another video clip found on-line that covers the answers to the questions mentioned above: <ul style="list-style-type: none"> Tour – South San Francisco Scavenger Company Garbage Disposal Recycling and Transfer Station https://www.youtube.com/watch?v=unXKla0Blws: Where Your Stuff Goes: From Curbside to Shoreway Environmental Center and Beyond.

Explore / Explain / Elaborate/ Evaluate	<p>The Lesson: Play the 4R's Unit Games (3 games) Depending on time and materials students may play just one game or more ~ 70 minutes total playing for all 3 games</p> <p>Teacher Guidelines:</p>
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	<ul style="list-style-type: none"> The teacher will divide students into groups of three or four. <i>For a virtual classroom setting (if students have access to the technology, teachers can put 3-4 students in a breakout room or schedule a Google classroom meeting for just those 3-4 students. If students cannot play virtually with classmates, they may be able to play Game 1 and Game 2 individually (please note - playing games individually would take twice as long) or students can play Game 1, Game 2, and Game 3 with family members.</i> Students will play each of the three 4R's games and do a review activity after each game. <i>For virtual classroom setting, students can debrief games in a larger group or stay with the small group in a breakout room. Teachers/facilitators can come into the breakout room to clarify or explain as the students need during the review of each game.</i> Video clip instructions on how to play these games are also available. Please email gschwartz@smcgov.org for access.
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Explore / Explain / Elaborate/ Evaluate	Game 1 - Where Does it Come From and Go?
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Time:	20 minutes
Directions for Activity:	<p>Engage/Explain Component:</p> <ul style="list-style-type: none"> Teacher will review the following instructions with students before playing the game (Teachers can also link this video to students to have an Solutions to Waste Schools Program staff member explain the game to students virtually: <ul style="list-style-type: none"> Organize the cards into the four categories (columns). Refer to the example in the first row (starting with trees, paper, etc.) Place “natural resource” cards in the 1st column Place item” cards in the 2nd column Place “recycled, landfilled, or composted” cards in the 3rd column Place “can the materials from this item be used to make anything else?” cards in the 4th column As students are placing the cards on the game board graphic organizer, the teacher will roam around the classroom and check for the students’ understanding of this aspect of the game. When students are finished placing the cards on the board, the teacher will check to see if each group has correctly completed the board. If some of the cards are not in the appropriate category, the teacher will point to the incorrect cards and guide students in placing the cards in the correct positions. <p>Elaborate and Evaluate Component:</p> <ul style="list-style-type: none"> After Game 1 is complete, the teacher will ask students to discuss amongst their small groups (ideally) or reflect individually (if playing games by themselves) the following topics: <ul style="list-style-type: none"> New facts they’ve learned from this game

		<ul style="list-style-type: none"> ○ Any questions that came up that they'd like to bring to the larger group ● Students should be given time to write down these new facts in a science notebook
Game 2 - The Pathway of Stuff (There are 3 versions of this game: in class version, take-home version, and on-line version)		
	Time:	25 minutes
	Directions for Activity:	<p>Engage/Explain Component for <i>in class</i> and <i>take home game version</i> :</p> <ul style="list-style-type: none"> ● The teacher will review the following instructions with students before playing the game: <ul style="list-style-type: none"> ○ Teachers can also link this video to students to have an Solutions to Waste Schools Program staff member explain the game to students virtually. ○ Follow the pathways of garbage (solid waste), recyclables (paper, plastic food containers, bottles & cans), organics (compostables), and reusable stuff after it gets picked up and taken away from our homes, schools, and local businesses. ○ Put the cards/pictures into the correct squares to complete the pathway of where stuff goes. ○ Start from towns and cities on the left-side of the board to the right (for class version) or start from the top of the board (for take-home version). ○ Don't forget to read the back of the cards! ● As the cards are being placed on the diagram by students, the teacher will roam around the classroom and check the students' understanding of the game. ● When students are finished placing the cards on the diagram, the teacher will check to see if each group has correctly completed the board. If some of the cards are not in the appropriate position, the teacher will point to the cards that are incorrect and guide the students in placing the cards in the correct positions. <p>Evaluate Component:</p> <ul style="list-style-type: none"> ● After Game 2 is complete, the teacher will ask students to discuss amongst their small groups or reflect individually (if playing games by themselves) the following topics: <ul style="list-style-type: none"> ○ What is the pathway of recyclables after they get picked up from your home? <ul style="list-style-type: none"> ■ Answer: <i>Recyclables</i> → <i>material recovery facility</i> → <i>factories / manufactures</i> (<i>Recyclables are made into</i>

		<p><i>new products.) → stores / retailers → homes, businesses, schools (New products are purchased.)</i></p> <ul style="list-style-type: none"> ○ What is the pathway of garbage after it gets picked up from your home? <ul style="list-style-type: none"> ■ Answer: <i>Garbage → transfer station → landfill (Garbage is buried in the landfill forever.)</i> ○ What is the pathway of organics or yard waste after it gets picked up from your home? <ul style="list-style-type: none"> ■ Answer: <i>Organics → transfer station → commercial composting facility (Organics are composted.) → homes, business, farms, (Compost is used as soil amendment in gardens and agricultural fields. Compost enriches the soil with nutrients.)</i> ○ What is the pathway of reusable stuff after it is picked up from your home? <ul style="list-style-type: none"> ■ Answer: <i>Donations → transferred by car → donation site → back to homes</i> <ul style="list-style-type: none"> ● Students should be given time to write down or draw these pathways in a science notebook
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Game 3 - The 4R's Board Game	
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Time:	30 minutes
Directions for Activity:	<p>Engage/Explain Component:</p> <ul style="list-style-type: none"> ● Review: Before students begin playing the game, the teacher will have students look at the visuals on the board and discuss (in small groups) the following questions. Answers can be written down in a science notebook. <ul style="list-style-type: none"> ○ How many pathways do you see on the board? <ul style="list-style-type: none"> ■ <i>Nine pathways</i> ○ What does each pathway represent? <ul style="list-style-type: none"> ■ <i>Reusable items going to a thrift store; garbage going to the landfill; yard waste and food waste being commercially composted; yard waste being composted at home; recyclables being made into new products; yard waste being landfilled; a couch being landfilled; and used books and toys being reused by being purchased at a garage sale.</i> ○ What is the difference between the pathways moving down the board and the pathways moving up the board? <ul style="list-style-type: none"> ■ <i>Pathways moving down the board are pathways that lead to the landfill. Pathways moving up the board are pathways that do not lead to the landfill; these pathways show items being reused, recycled, and composted.</i>

		<ul style="list-style-type: none"> ● The teacher will review the following rules and instructions with the students before playing the game: <ul style="list-style-type: none"> ○ Rules: <ul style="list-style-type: none"> ■ 1. Players must take turns in the same order as determined in the beginning of the game by rolling the dice; the player with the highest number spun or rolled goes first. ■ 2. Players cannot take two turns in a row. ■ 3. Toward the end of the board game the player does not have to roll the exact number of spaces for moving their piece to the finish square. For example, if the player's piece is on square 48 he/she does not have to roll a three to win but can roll a three or more and still win the game. ○ Summary of Instructions (detailed instructions are on the attached handout or link to video instructions) <ul style="list-style-type: none"> ■ Your pieces (bottle caps) move along the squares on the board in order from one to fifty. ■ Every time your piece (bottle cap) lands on a picture (showing reuse, recycling or rot/compost) you have to answer a "Fact Question" to skip spaces and move up the road to the final picture (of the process). ■ Every time your piece (bottle cap) lands on a picture showing the process of something being landfilled you have to answer a "Decision Question". If you do not answer the question correctly then you move down the road to the final picture. If you answer the question correctly then your piece stays at its current location (the square) until your next turn. <p>Evaluate Component:</p> <ul style="list-style-type: none"> ● After the game 3 is played, the teacher can ask "what did you learn from playing this?" Students can provide feedback in a think-pair-share format.
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	Post-Lesson Assessment	
Evaluate	Time:	15 - 25 minutes for each activity
	Directions for Activity:	1) 4R's Pre and Post Worksheet <ul style="list-style-type: none"> ● The teacher will review students' previous responses to each scenario (A, B, C, D, E) in the "Pre-Lesson Assessment" - linked here. ● Students will be instructed to answer the following questions for each scenario (question) directly on their previous student worksheet questionnaire or in their notebook:

		<ul style="list-style-type: none"> ○ Is there anything about your initial explanations for this scenario that you would like to change now that you have played the games? ● Students will use a different color pen as opposed to what was used earlier to answer these questions. This will help the teacher distinguish the changes from their previous statements. <p>2) Word Bank</p> <ul style="list-style-type: none"> ● Students will create a word bank using the new vocabulary that they learned during the lesson. The word bank may include the following words and others that the teacher would find appropriate for this lesson: recycle, reduce, reuse, rot/compost, organics, landfill, transfer station, transfer truck, material recovery facility, hauler, commercial compost facility, natural resource, raw material, leachate, and methane gas. <p>Example Word Bank:</p> <table border="1" data-bbox="509 827 1398 1073"> <thead> <tr> <th data-bbox="509 827 773 936">Word</th> <th data-bbox="773 827 1091 936">Your own definition</th> <th data-bbox="1091 827 1398 936">Picture or Example</th> </tr> </thead> <tbody> <tr> <td data-bbox="509 936 773 1005"><i>Compost</i></td> <td data-bbox="773 936 1091 1005"></td> <td data-bbox="1091 936 1398 1005"></td> </tr> <tr> <td data-bbox="509 1005 773 1073"><i>Leachate</i></td> <td data-bbox="773 1005 1091 1073"></td> <td data-bbox="1091 1005 1398 1073"></td> </tr> </tbody> </table> <p>3) Reflection questions</p> <ul style="list-style-type: none"> ● In the unit exam or quiz students will answer various questions about this lesson; these questions can be based on the pre-lesson assessment questions. 	Word	Your own definition	Picture or Example	<i>Compost</i>			<i>Leachate</i>		
Word	Your own definition	Picture or Example									
<i>Compost</i>											
<i>Leachate</i>											

Possible Elaborate Components:

- A. Students could play Game 1 and Game 2 again. However, this time they could compete against other groups to see which group has correctly completed the games first.

- B. Students could continue to play Game 3 – 4R’s Board Game and the teacher (or students) could create more decision and fact question cards for students to answer as a review.

- C. Students could tour a local material recovery facility and transfer station.

- D. Students could take action by implementing a school recycling or reuse program.

E. Students could develop a waste reduction and recycling campaign at school or in the surrounding community. Fellow students, school staff, and the community at-large could be educated through signage, the school's newsletter, assemblies / rallies, contests, and daily announcements, etc.

F. Students can work together to recognize their classroom or green team via the [Green Star School Certification program](#).