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Selection in Action

Obstacles

The following pages contain *Time/Cost Estimates*, *Shopping Lists*, *Prep Instructions* and *Activity Instuctions* for each obstacle. Each obstacle also has an *Evolutionary Analogue* section which provides a possible way to tie in the cars to their real life counterparts.

The following activities require the use of scissors: Hamster Wheel, Ramp and Path, Bubble Popping, Monster Pendulum, Ramp and Masking Tape, Seasons, Ultraviolet Box.

The following activities require the use of wire cutters: Bubble Popping, Monster Pendulum.

The following activity requires the use of a craft knife, glue gun and wire strippers: Vibrating Surface Station.

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Selection in Action - Obstacles

List of Obstacles

Depending on the teacher's resources and time, they may choose to build all of the obstacles, pick several of them or even create their own. One of the great features of this activity is that almost anything can be used as an obstacle; feel free to be creative.

Founder Effect: a subgroup of the population is dispersed and becomes isolated. Over time, speciation may occur.

Archway – "Arch Nemesis I & II": represents environmental changes or pressures that may restrict resources, which can influence selective pressures.

Speed Bump – "The Hurdle": clearing the bump represents a disease from which the individual must be able to recover.

Hamster Wheel: represents a natural disaster, such as a tsunami or hurricane, that the cars must survive.

Ramp/Path – "Rolling On Down": represents phenotypic variation in a population and the environment's ability to support different-sized cars, but only to a certain extent.

Ramp and Bubble Popping – "Pop Goes the Bubble": the car must be able to reach a fixed point which could represent a potential mate, a food source or shelter.

Monster Pendulum – "The Predator": represents a predator that each car must try to avoid.

Ramp and Masking Tape Perimeter – "Don't Get Out of Line": stopping within the boundary represents an organism's ability to acquire food or shelter in their environment.

Water and Ramp – "Not a Drop to Drink": each car must make it down the ramp and over a small hurdle in order to reach the water source.

Seasons: represents seasonal changes in the environment and the ability of an organism to survive them.

UV Box – "More Than Meets the Eye": illustrates the difference between phenotype (what can be seen on the outside) and genotype (an individual's genes) using a UV light and pen.

Vibrating Surface Station – "The Vibe": represents the ability to acquire food. The car must be able to hold onto a gumball while vibrating.

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Selection in Action - Obstacles

Shopping List

The lists are divided into consumable and reusable items. The listed cost assumes that the activity has never been performed before and that all of the materials must be purchased. The legend below provides details of where the materials can be found:

A = Arts and Crafts Store
D = Dollar Store
E = Educational Supplier
G = Grocery Store
H = Hardware Store
O = Online
P = Pharmacy
S = Specialty Store
U = University

OBSTACLE	INITIAL COST
Founder Effect	free
"Arch Nemesis I"	free
"Arch Nemesis II"	free
"The Hurdle"	free
Hamster Wheel	$26.00
"Rollin' on Down"	$1.00
"Pop Goes the Bubble"	$3.00
"The Predator"	$8.00
"Don't Get Out of Line"	free
"Not a Drop to Drink"	$17.00
Seasons	$3.00
"More Than Meets the Eye"	$59.00 - $74.00
"The Vibe"	$21.00
Total Cost	**$138.00 - $153.00**

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Selection in Action - Obstacles

Founder Effect

Prep Time: 5 min / Cost: free

Shopping List

REUSABLE ITEMS			
Item	**Quantity**	**Purchase Code**	**Total Cost**
Lego and K'Nex pieces	~30	E	already purchased
COST OF REUSABLE ITEMS:			**free**

Prep Instructions

Create two archways using Lego and K'Nex pieces. The first should be quite large, around 6 in. wide and 8 in. high. Place this archway to the left. The second archway should be smaller, around 3 in. wide and 4 in. high. Place this archway to the right. Both arches should be on a flat surface with room for the cars to go through them.

Activity Instructions

All cars are assigned a sequential number. For example, if there are 15 cars, then number them 1-15. Odd numbered cars must go to the left/large archway and even numbered cars must go to the right/small archway. Most of the cars going to the left will fit through the archway. Only some of the cars going to the right will fit through.

Evolutionary Analogue

A natural disaster has dispersed a population of individuals. Most of those who go through the larger archway on the left will likely fit through and survive. Those who go through the archway on the right will only fit through if they are small. Therefore, those cars who survive the small archway will likely be fewer in number and more similar in size. Therefore, they will have less genetic diversity than the original population.

Over time, speciation of the smaller population may occur, especially if they remain isolated from the original population and their new environment has different constraints such as new predators, climate or topography.

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Selection in Action - Obstacles

Archway
"Arch Nemesis I"

Prep Time: 5 min / Cost: free

Shopping List

REUSABLE ITEMS			
Item	**Amount Required**	**Purchase Code**	**Total Cost**
Lego or K'Nex pieces	10	E	already purchased
COST OF REUSABLE ITEMS:			**free**

Prep Instructions

Create a sturdy archway or tunnel using Lego or K'Nex pieces (**Figure 1**).

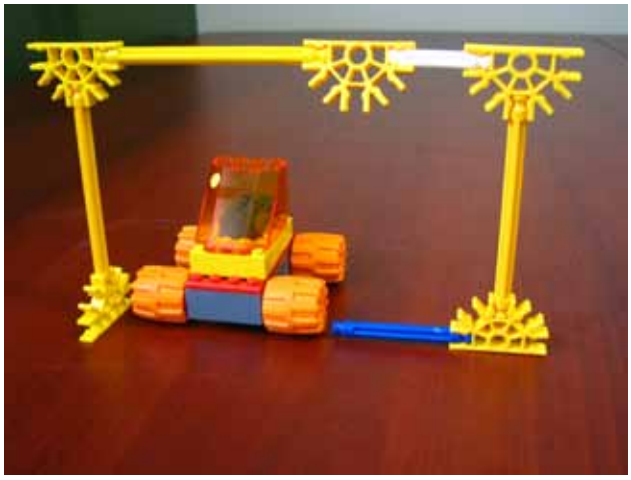

Figure 1

Activity Instructions

Place the archway or tunnel on the table and have students push their car through. If the car is too tall or too wide, it will not fit.

Evolutionary Analogue

The archway represents environmental changes or pressures that may restrict resources, which can influence selective pressures.

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Selection in Action - Obstacles

Archway (Round 2)
"Arch Nemesis II"

Prep Time: 5 min / Cost: free

Shopping List

REUSABLE ITEMS			
Item	**Amount Required**	**Purchase Code**	**Total Cost**
Lego or K'Nex pieces	10	E	already purchased
COST OF REUSABLE ITEMS:			**free**

Prep Instructions

Create a sturdy archway or tunnel using the blocks. Make sure this arch is larger or smaller than Arch Nemesis I. The activity is identical, but the dimensions of the arch will be different.

Figure 2

Activity Instructions

Place the archway or tunnel on the table, and have students push their car through, as in **figure 2**. If the car is too tall or too wide, it will not fit.

Evolutionary Analogue

While there is a range of variation in all populations, individuals that are on the extreme ends may not survive. At one point in time, the environment may support very large cars, at another time it may support small cars.

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Selection in Action - Obstacles

Speed Bump
"The Hurdle"

Prep Time: 3 min / Cost: free

Shopping List

REUSABLE ITEMS			
Item	**Amount Required**	**Purchase Code**	**Total Cost**
2-by-4 dot Lego blocks	4	E	already purchased
masking tape	several 5 cm strips	D	already purchased
COST OF REUSABLE ITEMS:			**free**

Prep Instructions

Tape the blocks down on a table **(Figure 3)**. Create a start line with masking tape from which the student must push the car.

Activity Instructions

Push a car from the start line and see if it can clear the small hurdle, represented by a Lego piece. Students should not touch the car after they have pushed it off of the start line.

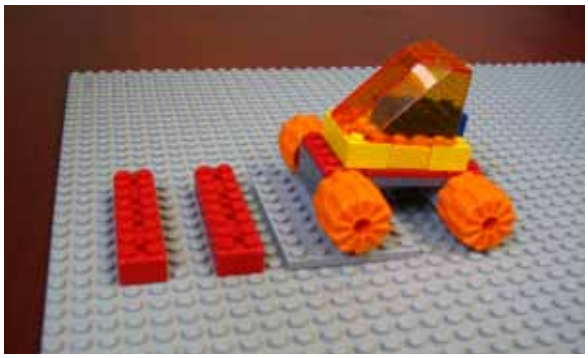

Figure 3

Evolutionary Analogue

Each hurdle represents a disease from which the individual must be able to recover. Not being able to pass over a hurdle represents not being able to recover from the disease.

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Selection in Action - Obstacles

Hamster Wheel

Prep Time: 5 min / Cost: $26.00

Shopping List

REUSABLE ITEMS			
Item	**Amount Required**	**Purchase Code**	**Total Cost**
hamster wheel	1	S (Pet Store)	$25.00
Bristol board	1 sheet	D	$1.00
COST OF REUSABLE ITEMS:			**$26.00**

Prep Instructions

If desired, cover half of the hamster wheel with cut-out pieces of Bristol board, such as in **figure 4**, so that the cars do not fall out easily.

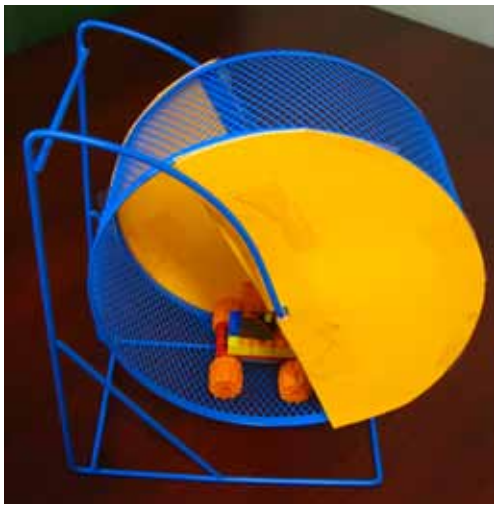

Figure 4

Activity Instructions

Place each car, one by one, inside the wheel. Spin the wheel for three seconds and see if the car survives without any pieces breaking off.

Evolutionary Analogue

The hamster wheel represents a natural disaster, such as a tsunami or hurricane, that the cars have to survive.

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Selection in Action - Obstacles

Ramp and Path
"Rollin' on Down"

Prep Time: 10 min / Cost: $1.00

Shopping List

REUSABLE ITEMS			
Item	**Amount Required**	**Purchase Code**	**Total Cost**
paper cups	20	D	$1.00
clear tape	30 cm	D	already purchased
24 in. x 36 in. piece of cardboard	1	—	free
24 in. x 4 in. piece of cardboard	2	—	free
COST OF REUSABLE ITEMS:			**$1.00**

Prep Instructions

Place the large piece of cardboard on the table. Stack the cups to create a foundation for two inclined planes. Place the two rectangular cardboard pieces as the tracks on top of the stacked cups. Cut the cardboard to an appropriate size and secure with tape if needed. If desired, decorate the ramp with construction paper or wrapping paper.

Figure 5

Activity Instructions

The cars must roll down the inclined plane without falling or be able to pass in between the path created by the cups such as in **figure 5**.

Evolutionary Analogue

This obstacle represents variation in a population and the environment's capacity to support different variations of a trait, such as size.

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Selection in Action - Obstacles

Bubble Popping
"Pop Goes the Bubble"

Prep Time: 10 min / Cost: $3.00

Shopping List

This obstacle uses the ramp from "Don't Get Out of Line" and assumes that it has been created.

CONSUMABLE ITEMS			
Item	**Amount Required**	**Purchase Code**	**Total Cost**
dish soap	50 mL	D	$1.00 (for 500 mL)
water	2 L	—	free
COST OF CONSUMABLE ITEMS:			**$1.00**

REUSABLE ITEMS			
Item	**Amount Required**	**Purchase Code**	**Total Cost**
large water basin	1	D	$1.00
large bubble blower or coat hanger	1	D	$1.00
masking tape	20 cm	D	already purchased
Ramp and Masking Tape obstacle*	1	—	free
COST OF REUSABLE ITEMS:			**$2.00**

Prep Instructions

To create a bubble blower, unwind a metal coat hanger and re-shape it into a circle. Fill the basin with water and bubble mix. Create a line on the floor about two feet from the edge of the ramp. This is where the bubble blower will be held in place to see if the cars can pop the bubble.

Activity Instructions

Dip the bubble blower into the bubble mix. Make sure the blower is completely submerged so that a soap film covers the entire blower. Place the bubble blower so that it rests upright on the floor. It should be roughly two feet away from the bottom of the ramp.

Place each car on top of the ramp (**Figure 6**). Have the cars go down the ramp and see if they can coast in a straight line towards the bubble. The cars must hit the bubble blower and pop the bubble.

Evolutionary Analogue

The car must be able to reach a fixed point which could represent a potential mate, a food source or shelter.

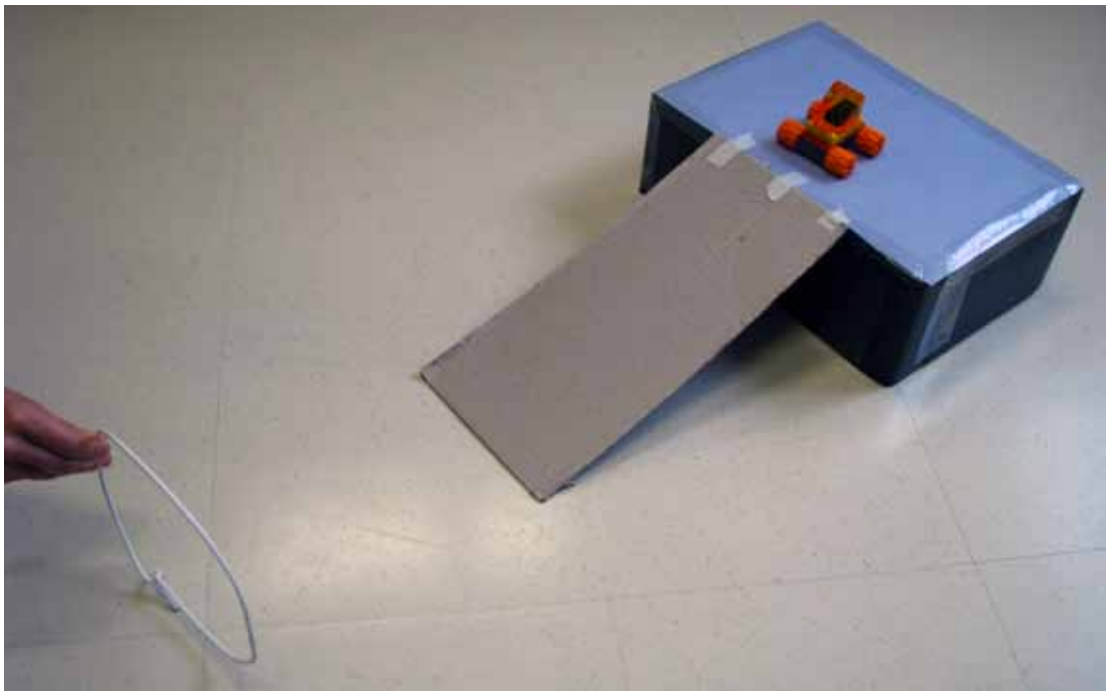

Figure 6

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Selection in Action - Obstacles

Monster Pendulum
"The Predator"

Prep Time: 25 min / Cost: $8.00

Shopping List

REUSABLE ITEMS			
Item	**Amount Required**	**Purchase Code**	**Total Cost**
tennis balls	1-2	D	$1.00
string	1 roll	D	$1.00
decorations (construction paper, markers)	—	D	$5.00
plastic drinking straws	1 package	D	$1.00
clear tape	30 cm	D	already purchased
24" x 36" cardboard box	1	—	free
wire coat hanger	1-2	—	free
COST OF REUSABLE ITEMS:			**$8.00**

Prep Instructions - Pendulum with One Tennis Ball

Step 1

Cut an arch-shaped hole on two sides of the box to create a tunnel.

Step 2

Using wire cutters, cut the bottom piece of a wire coat hanger. Keep the long, straight metal piece (**Figure 7**).

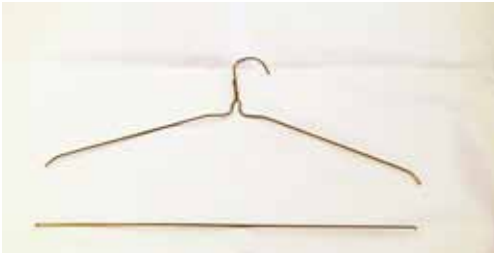

Figure 7

Step 3

Turn the box upside down. Attach the straight metal piece from the coat hanger to the middle of the box so that it is right in the middle of the tunnel (**Figure 8**).

Figure 8

Step 4

Take a piece of string and wrap it around the tennis ball. Use clear tape to secure the string to the ball (**Figure 9**).

Step 5

Tie the string to the straight metal piece from the coat hanger. Use clear tape to secure if needed.

Step 6

Turn the tunnel right side up and give the tennis ball a push. It should swing back and forth like a pendulum.

If desired, decorate the box to make it look like a predator using construction paper and markers.

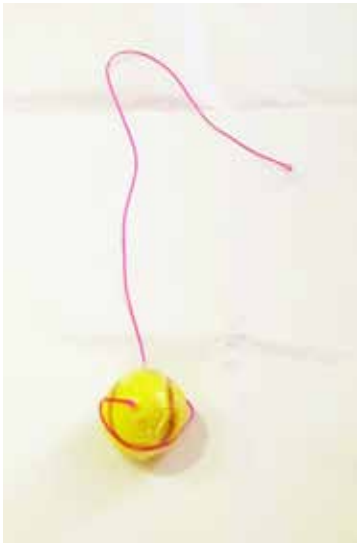

Figure 9

Prep Instructions - Pendulum with Two Tennis Balls

Before continuing on, Steps 1-3 from the previous section should be performed.

Step 1

Take a piece of string and wrap it around the tennis ball. The string length should vary based on the height of the box. Use clear tape to secure the string to the ball (**Figure 9**). Repeat for a second ball.

Step 2

Feed the length of the string through several plastic straws, leaving a few inches free at the top so that it can be attached to the metal piece. Do this for both tennis balls.

Step 3

Attach the end of the strings to the metal piece and tie or tape them in place. Leave about five inches between each tennis ball (**Figure 10**). Use clear tape to secure both sides of each knot in place on the metal wire, so that the two tennis balls do not slide together and collide.

Figure 10

Step 4

Turn the box right side up and push each tennis ball from opposite sides. If desired, decorate the box using construction paper and markers to make it look like a predator (**Figure 11**).

Figure 11

Activity Instructions

Push the tennis balls so that they swing from side to side like a pendulum. One by one, have each student push their car through the archway. The object is to make it through to the other side. If the car is hit but still manages to make it through, it will still survive.

Evolutionary Analogue

This obstacle represents a predator that each car must try to avoid.

Ramp and Masking Tape "Don't Get Out of Line"

Prep Time: 7 min / Cost: free

Shopping List

REUSABLE ITEMS			
Item	**Amount Required**	**Purchase Code**	**Total Cost**
masking tape	1 m	D	already purchased
12 in. x 8 in. piece of strong cardboard	1	—	free
empty shoebox	1	—	free
COST OF REUSABLE ITEMS:			**free**

Prep Instructions

Tape the piece of cardboard (cut to size if necessary) to the edge of the shoebox to make a ramp. Create a square, around two to three feet away from the shoebox, on the floor using masking tape. Make a smaller square if the floor is carpeted.

Activity Instructions

The car starts at the top of the ramp. The student gives the car a slight push and sends it down the ramp. The car must stop within the boundaries (**Figure 12**).

Figure 12

Evolutionary Analogue

Individuals must have a means of locomotion in order to survive. Stopping within the boundary represents an organism's ability to acquire food or shelter in their environment.

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Selection in Action - Obstacles

Water and Ramp
"Not a Drop to Drink"

Prep Time: 7 min / Cost: $17.00

Shopping List

REUSABLE ITEMS			
Item	**Amount Required**	**Purchase Code**	**Total Cost**
5 L capacity plastic basin	1	D	$1.00
plastic straws	50	D	$1.00 (for a pack)
clear tape	50 cm	D	already purchased
24 in. ramp made of waterproof materials (hotwheels ramp, plastic lid, etc.)	1	E/D	$15.00
COST OF REUSABLE ITEMS:			**$17.00**

Prep Instructions

Tape several plastic straws together to form a bundle and tape it in the middle of the ramp to form a hurdle. More than one hurdle can be constructed if desired. Lean the ramp against a chair or other object and place the end in the basin **(Figure 13)**. Fill the basin with water.

Figure 13

Activity Instructions

Have students release their cars down the ramp one at a time. See if they can clear the hurdle in order to land in the basin in one piece.

Evolutionary Analogue

Each car must be able to make it down the ramp and over the small hurdle in order to reach the water source and survive.

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Selection in Action - Obstacles

Seasons

Prep Time: 21 min / Cost: $3.00

Shopping List

REUSABLE ITEMS			
Item	**Amount Required**	**Purchase Code**	**Total Cost**
coloured construction paper	1 pack	D	$1.00
white paper or styrofoam plate	1	D	$1.00 (for a pack)
gumballs or marbles	1 pack	D	$1.00
clear tape	several 5 cm strips	D	already purchased
24 in. x 36 in. piece of cardboard	1	—	free
toilet paper	1 roll	—	free
small box or container (500 mL)	1	—	free
COST OF REUSABLE ITEMS:			**$3.00**

Prep Instructions

Step 1

Divide a large piece of cardboard into three sections: spring/summer, fall and winter. Cover the cardboard with green paper for spring/summer, orange for fall and white for winter.

Step 2

For the spring/summer section, create a pathway lined by construction paper trees. To make the trees, roll pieces of construction paper into a cone shape and secure with a piece of tape to the base. The cars must fit between the trees in order to survive.

Step 3

For the fall section, place the small box or container in the middle of the board. Fill it with gumballs.

Step 4

For the winter section, create a shelter by placing a toilet paper roll upright on the cardboard. Place a paper or styrofoam plate on an angle, leaning against the toilet paper roll. This is the shelter that the car must fit under. The completed obstacle can be seen in **figure 14**.

Figure 14

Activity Instructions

Each car must pass through "spring/summer", which is the pathway lined with trees. Cars that are too large to fit through do not survive.

When the car reaches "fall", it must pick up a gumball (which represents food) and be able to carry it.

As the car reaches "winter", it must fit inside the shelter (styrofoam plate).

Evolutionary Analogue

This obstacle represents seasonal changes in the environment and the ability of an organism to survive them.

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Selection in Action - Obstacles

Ultraviolet Box
"More Than Meets the Eye"

Prep Time: 25 min / Cost: $59.00 - $74.00

Shopping List

CONSUMABLE ITEMS			
Item	**Amount Required**	**Purchase Code**	**Total Cost**
yellow sticker dots	1 pack	D	$3.00
paper	15	—	$1.00 (for a pack)
COST OF CONSUMABLE ITEMS:			**$4.00**

REUSABLE ITEMS			
Item	**Amount Required**	**Purchase Code**	**Total Cost**
ultraviolet (UV) lamp	1	E	$45.00
UV pen	1	E	$8.00
black construction paper	1 pack	D	$2.00
clear tape	several 5 cm strips	D	already purchased
Lazy Susan (optional)	1	H	$15.00
12 in. x 12 in. x 18 in. cardboard box (with lid attatched)	1	—	free
COST OF REUSABLE ITEMS:			**$55.00 - $70.00**

Prep Instructions

Figure 15

Step 1

Cut a hole in the middle of the lid of the box so that the UV light may be placed over it (**Figure 15**).

Step 2

Cut a hole, about 2 in. high and 4 in. wide, in one side of the box so that students can look through and see their car. The hole should be close to the top of the box. If the box already has a hole of similar dimensions then there is no need to make another.

Step 3

On the same side of the box, cut another hole about 3 in. high and 6 in. wide near the bottom, so that students can put their hand through to turn the Lazy Susan. It is also an option to only make three cuts, leaving the top attached to create a flap so that the light does not enter through the hole after the Lazy Susan has been moved.

Step 4

Cover the box with black construction paper and place the UV light facedown on top of the box. Take a package of yellow stickers and, using a UV pen, mark every second sticker with an X.

Activity Instructions

Place a sticker on each of the cars and, one at a time, place the cars inside the box. Close the lid. Turn on the UV light so that it shines downward into the box. Ask the student to look into the side of the box and see if their sticker has a mark on it. Turn off the UV light and have the student remove their car.

If their sticker has an X, give them a piece of paper. Do not tell them what this means until everyone has had a chance to perform the activity.

Evolutionary Analogue

This obstacle illustrates the difference between phenotype (what can be seen on the outside) and genotype (an individual's genes). The X on the sticker that is only visible under the UV light represents an organism's natural immunity to a prevalent disease. Cars with an X are likely to survive if an outbreak occurs.

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Selection in Action - Obstacles

Vibrating Surface Station
"The Vibe"

Prep Time: 30 min / Cost: $21.00

Shopping List

REUSABLE ITEMS			
Item	**Amount Required**	**Purchase Code**	**Total Cost**
electric motor	2	E	$7.00
9-volt battery connector cap	1	E	$1.00
1/4 in. x 4 in. x 36 in. piece balsa wood	1	H	$5.00
9-volt battery	1	H	$3.00
thumbtacks	2	D	$1.00
gumball	1	D	$1.00
paper clip	1	D	$1.00
insulated wire	18 in.	H	$2.00
pennies	2	—	free
shoe box	1	—	free
COST OF REUSABLE ITEMS:			**$21.00**

Prep Instructions

Step 1

Cut the piece of balsa wood into the following pieces as shown in **figure 16**:
- two 2 in. x 2 in.
- three 1/2 in. x 2 in.

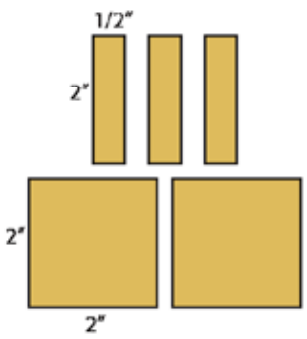

Figure 16

Step 2

Cut the insulated wire into four 4 in. long pieces. For each wire, strip a 1/2 in. piece off of each end.

Step 3

Using a 4 in. wire, connect the lead on one motor to a lead of the other. Twist the ends of the wire around themselves to ensure that the wire will stay on.

Attach another 4 in. wire to the open terminal of one motor and a second 4 in. wire to the open terminal of the other motor (**Figure 17)**.

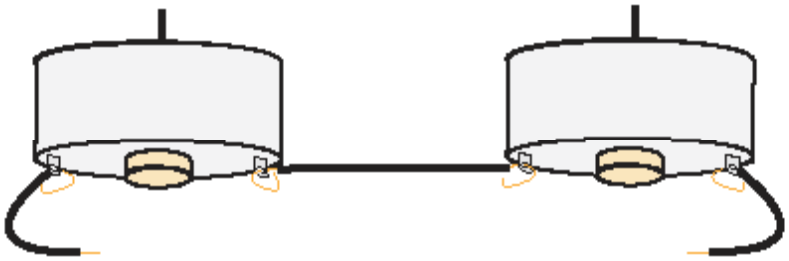

Figure 17

Step 4

Take the two pieces of 2 in. x 2 in. balsa wood; these pieces of wood will serve as a base to attach the electric motors to the top of the shoe box. With the craft knife, cut out any needed indentations in the wood to allow the electric motors to sit as flat as possible on top of the bases (**Figure 18**).

Step 5

Using a hot glue gun, glue the wired motors onto the pieces of balsa wood.

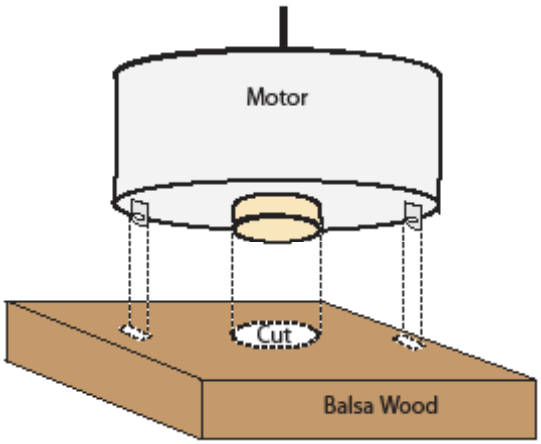

Figure 18

Step 6

Glue the bottom of the balsa wood bases to the underside of the shoe box top. Attach the battery cap to the 9 V battery and glue the battery to the underside of the shoe box, ensuring that it is equidistant from both motors (**Figure 19**). Attach the black wire from the battery cap to the open wire of the closest motor to the battery.

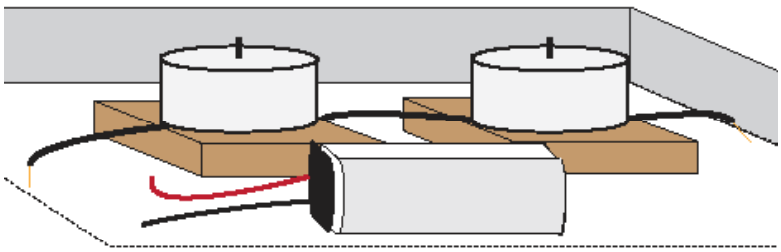

Figure 19

Step 7

Take one of the 1/2 in. x 2 in. pieces of balsa wood and press the far side of the piece onto the axle of one of the motors, punching a hole through the balsa wood (**Figure 20**). Remove the wood and place a bead of hot glue on the axle and then replace the wood on the axle, squishing the glue into the hole. It is important not to push the wood all the way down the axle otherwise the motor will not be able to rotate freely. Repeat with the second motor.

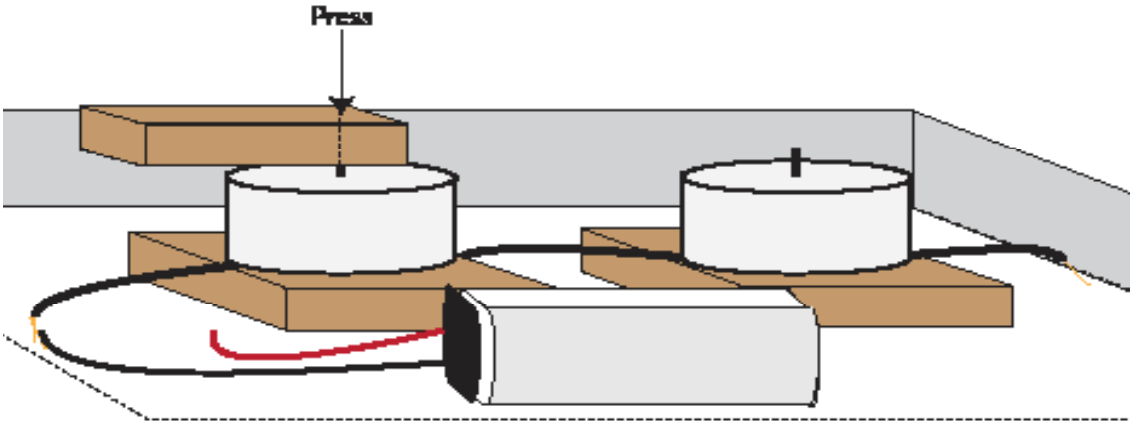

Figure 20

Step 8

Glue a penny on the end of the balsa wood furthest from the motor axle. Repeat with a second penny on the other piece of balsa wood (**Figure 21**).

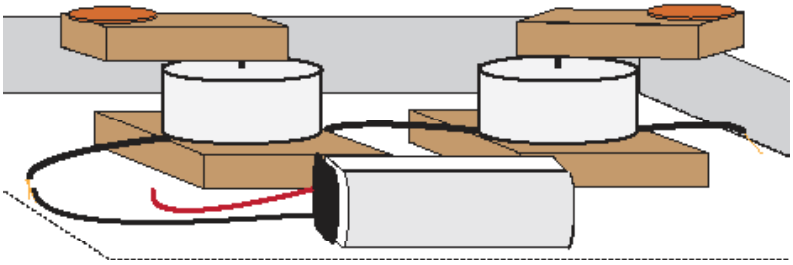

Figure 21

Figure 22

Step 9

Attach the final 4 in. piece of wire to the red wire attached to the battery cap. Punch two holes 2 in. apart through the shoe box top near a corner and feed the two untethered wires through the holes. The setup should resemble **figure 22**.

Step 10

Carefully flip the box top over. Glue the last 1/2 in. x 2 in. piece of balsa wood in the corner of the box top. It should rest snuggly in between the two wires.

Step 11

Wrap one of the wire ends around a thumbtack. Place a bead of hot glue on the tip of the tack and press it in the balsa wood on the side closest to where the wire comes through the box. Make sure that as the glue dries, the wire remains in contact with the thumbtack.

Step 12

Take the other wire and wrap it around a second thumbtack. Place a bead of hot glue on the tip of the tack and thread a paper clip on the tack before pushing it into the side of the balsa wood opposite the other tack (**Figure 23**).

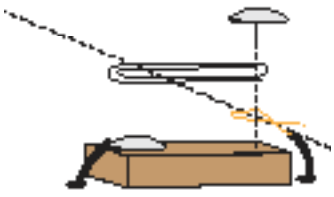

Figure 23

Step 13

The paper clip and the two thumbtacks can now function as a switch. When the paper clip touches both the thumbtacks, the motors should begin spinning which will cause the box top to vibrate.

Activity Instructions

Have students take a gumball and place it anywhere on or inside their car. One at a time, place each car on top of the vibrating platform (the lid of the shoe box).

Use the paper clip switch to turn the obstacle on for three seconds (**Figure 24**). The car should now be vibrating. After three seconds have elapsed, check if the car has managed to hold on to their gumball.

Some students may try to turn their car upside down or sideways in order to find a better position for the object. This is allowed.

Figure 24

Evolutionary Analogue

This obstacle represents the ability to acquire and hold on to food. The car must be able to hold onto a gumball while vibrating.