GYSTC
GEORGIA YOUTH SCIENCE & TECHNOLOGY CENTERS

Title: Elevators Rise to the Top STEM Challenge

Estimated Time: 1-2 periods

Core Ideas (GSE Standard and elements):

S4P3. Obtain, evaluate, and communicate information about the relationship between balanced and unbalanced forces.

a. Plan and carry out an investigation on the effects of balanced and unbalanced forces on an object and communicate the results.
b. Construct an argument to support the claim that gravitational force affects the motion of an object.

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S8P3. Obtain, evaluate, and communicate information about cause and effect relationships between force, mass, and the motion of objects.

b. Construct an explanation using Newton's Laws of Motion to describe the effects of balanced and unbalanced forces on the motion of an object.

Literacy Connections: Books	**Literacy Connections: Close Reads**
Equal Shmequal, Virginia Kroll Zombies and Forces and Motion, Mark Weakland	Elevators Rise to the Top
Science and Engineering Practices: **Planning and Carrying Out Investigations:** Conduct an investigation and/or evaluate and/or revise the experimental design to produce data to serve as the basis for evidence that meet the goals of the investigation. **Constructing Explanations and Designing Solutions:** Apply scientific ideas or principles to design, construct, and/or test a design of an object, tool, process or system.	**Crosscutting Concepts:** **Structure and Function:** The way an object is structured/designed determines many of its properties and functions. **Stability and Change:** For designed systems, conditions that affect stability and factors that control rates of change are critical to consider and understand.

STEM Challenge Overview:

In this STEM Challenge, the student's task is to build a working model of an elevator that uses a cranking device to move an object to the top of a structure.

Ask	Have you ever wanted an elevator to use in your house or school? While walking up stairs is good for us, they are hard to climb up because you have to work against the force of gravity that is pulling back toward the ground. Each time you take a step up, you have to push with a force equal to the weight of your body.

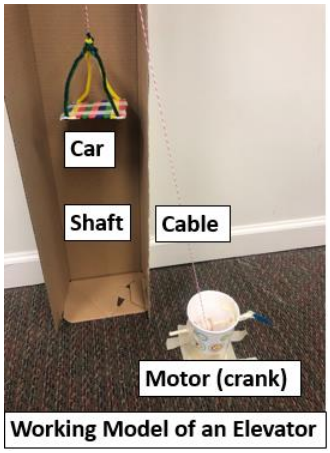
	Luckily, we have elevators in most buildings that are very tall. How do you think an elevator works to move people and things up so quick and smoothly?
Imagine/Brainstorm	Students **brainstorm** ideas for how they could design and construct their own elevator. The elevator should be capable of lifting a real object that has a measurable weight. After brainstorming, they should consider the strengths and weaknesses of each idea.
Plan/Design	In order to learn more about topic, have them read the ***Elevators Rise to Top*** article and discuss how elevators are often used to lift people and objects. It is a good idea to briefly discuss the basic parts of an elevator and how each of them functions. After learning about elevators, students **plan** and **design** a simple model elevator that can lift an object to the top of their elevator using a crank to provide the pull. Depending on the level of your students and the time you have for this challenge, you can make this open-ended or guided inquiry for your students. If you take a more open-ended approach, provide a variety of materials that can be used to construct the elevator.
Create/Test	Students follow their plan, and **create** their model elevator. Once it is created, students **test** their elevator in a measureable way to evaluate the effectiveness of their solution. Their results should be recorded, organized, and analyzed.
Improve	After discussing and evaluating their results, students improve their solution and re-test if possible.

Teacher Notes:

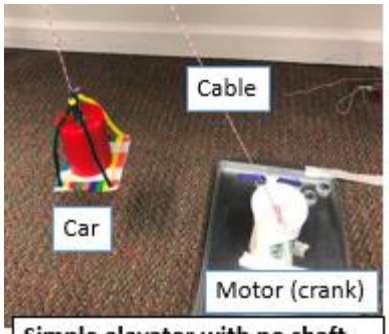
Forces are interactions between objects that cause a push or a pull between them. Forces can move objects that are at rest or stop objects that are moving. The force of gravity is the attractive force between any two objects that have a mass. The amount of attractive force depends on the mass of the objects and the distance between them. Since the earth is by far the most massive object in our vicinity, it exerts the strongest attractive forces on the objects around it. When building structures like elevators that are impacted by this gravitational pull, careful consideration and thoughtful engineering must be employed.

When designed well, elevators are super useful machines. They lift people (and other things) up and down in tall buildings where it would be difficult to move up using a just stairway or a ramp. In order to move people up, elevators must pull with a force strong enough to overcome the force of **gravity** that pulls down on both the elevator and the things inside it. In order to move them down, they must move smoothly and safety as the brakes are applied.

The basic parts of an elevator include a car, shaft, motor (cranking device), cable, and a counterweight. The **car** provides a sturdy and safe area for people to ride up and down. The **shaft** provides the tunnel like structure where the car can move safely from floor to floor. The **motor**, or cranking device, provides the power needed to pull the elevator to the top. The **cable** attaches to the motor, the top of the shaft, and the car.



Working Model of an Elevator



Simple elevator with no shaft

In this STEM Challenge, the student's task is to build a working model of an elevator that uses a cranking device to move an object to the top of a structure. The elevator should include a car, motor (cranking device), and a cable, at the minimum. I would also encourage students to include an elevator shaft made of cardboard and or foam board (elevators can also be make without a shaft by using a paperclip to hang the cable from the bottom of a table). The elevator should be able to lift an object (mass) from the bottom to the top using the crank as a motor to propel it. As an extension, you can also have students add a counterweight. You can designate the amount of mass, choose certain objects to align with holidays or events (miniature pumpkin for Halloween), or let students choose. A wide candle or 10-15 large glass gems from the Dollar Store work very well.

In designing their cranking device to serve as a motor, students can use a dowel rod or stiff straw to serve as the shaft that spins to wind up or wind down the cable. If they attach a popsicle stick or similar structure to one end, this makes the lifting easier as they gain a considerable mechanical advantage (if your students are at the appropriate level you can also calculate the mechanical advantage). It also helps to use tape to secure the cranking device to the floor or table.

After initial construction is completed, students should develop some method to measure the effectiveness of the elevator. After discussing and evaluating their results, they should make at least one substantial improvement and then re-test is possible. As they do so, try to emphasize the cyclical nature of the engineering process.

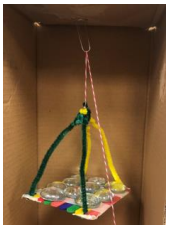
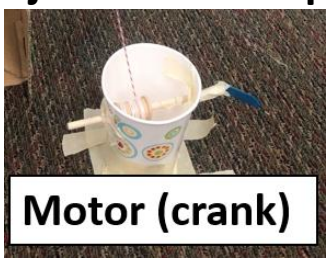
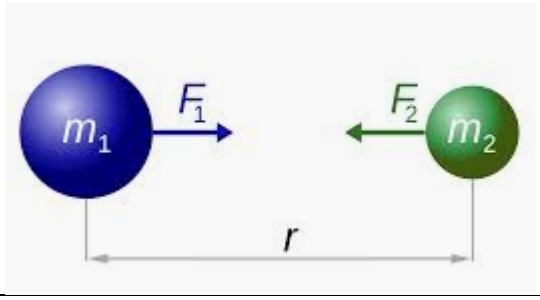
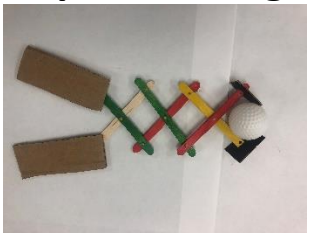
With respect to crosscutting concepts, the elevator provides an excellent example of the relationship between structure and function of the intertwined parts in this system. The elevator also shows how, for designed systems, conditions that affect stability and factors that control rates of change are critical to consider and understand.

Materials Suggested (per group):

Popsicle sticks, unifix cubes, and/or paper cups (for car).
Dowel rod or stiff straw
String
Masking tape
Paper clip or ring clip
Candle, glass gems, or similar masses.
Cardboard or foam board (shaft).
Spool (optional)
Other assorted items you have available

Key materials for Elevator Challenge

Vocabulary Cards:

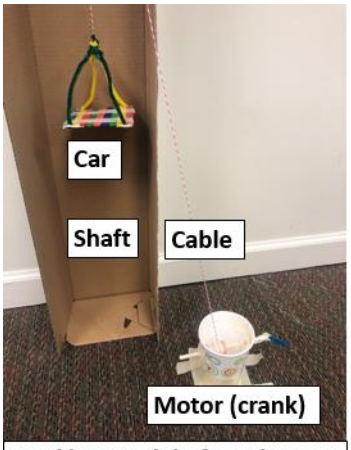
force **a push or pull** 	**elevator** **a machine that lifts things up** 
car **a safe area for objects to ride** 	**motor** **provides the power to pull the objects to the top** 
gravity **the force that attracts two objects towards each other** 	**engineer** **to design, build, and improve things** 

Elevators Rise to the TOP STEM Challenge:

Can you design, build, and test a model elevator that will lift an object to the top of the shaft?

Designing and constructing your elevator:

1. After learning about elevators, **plan** and **design** a simple model elevator that can lift an object to the top of their elevator using a crank to provide the pull.
2. Using the materials provided and your plan, **construct** your model elevator. Your elevator should include a car, shaft, cable, and motor.
3. As time permits, decorate your elevator to make it look as cool as possible.
4. Once the elevator is constructed, carefully **test** it by using the crank to lift you object to the top of the elevator. Observe and record how it responds.



Working Model of an Elevator

Evaluating and Improving:

1. As a group, discuss how you were able to construct your elevator and explain how the motor (crank) was used to overcome the force of gravity.

2. As a group, **evaluate** the effectiveness of your design and discuss how you would change your design moving forward to **improve** the performance of your projector. If time permits, make these improvements and re-test.

3. With respect to crosscutting concepts, describe how the elevator provides an excellent example of the relationship between structure and function.

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