04

The Smallpeice Trust

ENGINEERING @SCHOOL

The Marble Run Challenge

Subject: STEM/Engineering

Year group: 2-6

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Dare to imagine

#EngineeringAtSchool

PARACHUTE TEACHER GUIDANCE

This activity can be used as one of eight towards students obtaining the CREST SuperStar Award.

What Is CREST?

CREST is a nationally recognised scheme for student-led project work in the STEM subjects (science, technology, engineering and maths).

CREST gives young people aged 5–19 the chance to choose their own subject and methodology when completing their hands-on investigation.

CREST provides activities and project ideas for a range of ages, group size and abilities. From off-the-shelf, one-hour long challenges through to large-scale, student-led projects of over 70 hours work or more, CREST can be done by anyone.

What is CREST SuperStar?

SuperStar level is designed to be easy-to-run and low-cost for children typically aged 7-11 years. Children gain an Award by completing eight challenges.

You can download a CREST SuperStar passport template for your students to track their progress once you create an account via

www.crestawards.org/crest-superstar

ENTRY FEE per child: £1 UK / £4 International*

Within four weeks of payment, you will receive certificates and fabric badges to give out to your class.

LENGTH OF LESSON: 1-2 HOURS

How to make your Marble Run:

https://bit.ly/3fReApG

LESSON OVERVIEW

Students work in teams of "engineers" to design and build their own marble run out of everyday items. They test their marble run, evaluate their results, and present to the class.

Learning Objectives

During this lesson, students will:

- Design and construct a marble run
- Measure the height and velocity
- Test and refine their designs
- Communicate their design process and results

Learning Outcomes

- To consolidate the concept of gravity and kinetic energy
- To design and build models by using different materials and to test selected functional characteristic of the model built with the chosen materials

Key Vocabulary:

FORCES, GRAVITY, KINETIC ENERGY, GRAVITATIONAL POTENTIAL ENERGY, VELOCITY, HEIGHT

Curriculum links

SCIENCE KEY STAGE 2

- Explain that unsupported objects fall towards the Earth because of the force of gravity acting between the Earth and the falling object
- Working scientifically: asking relevant questions and using different types of scientific enquiries to answer them
- Working scientifically: setting up simple practical enquiries, comparative and fair tests
- Working scientifically: making systematic and careful observations and, where appropriate, taking accurate measurements using standard units, using a range of equipment, including thermometers and data loggers
- Working scientifically: gathering, recording, classifying and presenting data in a variety of ways to help in answering questions
- Working scientifically: recording findings using simple scientific language, drawings, labelled diagrams, keys, bar charts, and tables
- Working scientifically: using results to draw simple conclusions, make predictions for new values, suggest improvements and raise further questions

SCIENCE KEY STAGE 3

- Comparing amounts of energy transferred (J, kJ, kW hour)
- Other processes that involve energy transfer: changing motion, dropping an object, completing an electrical circuit, stretching a spring, metabolism of food, burning fuels

MATHS KEY STAGE 2

- Convert between different units of measure [for example, kilometre to metre; hour to minute]

DESIGN & TECHNOLOGY KEY STAGE 2

- Use research and develop design criteria to inform the design of innovative, functional, appealing products that are fit for purpose, aimed at individuals or groups
- Generate, develop, model and communicate their ideas through discussion, annotated sketches, cross-sectional and exploded diagrams, prototypes, pattern pieces and computer-aided design
- Select from and use a wider range of tools and equipment to perform practical tasks [for example, cutting, shaping, joining and finishing], accurately
- Apply their understanding of how to strengthen, stiffen and reinforce more complex structures

INTRODUCTION

What is a Marble Run?

Explain to students that: A marble run is a toy consisting of a track with bends, obstacles, etc. that marbles can be made to run down using the force of gravity.

What is Gravity?

Explain to students that: Gravity is a force of attraction that pulls together all matter (anything you can physically touch). The more matter something has, the greater the force of its gravity. For example, the Sun has much more gravity than Earth, but we stay on Earth's surface instead of being pulled to the Sun because we are much closer to Earth.

What is Energy?

Explain to students that: Energy is the capacity to do work. The unit of energy is J (Joule) which is also kg m^2/s^2 (kilogram metre squared per second squared).

What is Gravitational Potential energy?

Explain to students that: If an object is lifted, work is done against the force of gravity. When work is done energy is transferred to the object and it gains gravitational potential energy. If the object falls from that height, the same amount of work would have to be done by the force of gravity to bring it back to the Earth's surface.

What is Kinetic Energy?

Explain to students that: Kinetic energy is the energy an object has due to its motion. If an object is moving at the same velocity, it will maintain the same kinetic energy. The kinetic energy of an object is calculated from the velocity and the mass of the object.

How does gravitational potential energy transfer to kinetic energy?

Explain to students that: Gravitational potential energy is due to an object being stationary at a height. When falling, an object's gravitational potential energy converts into Kinetic Energy.

Newton's Laws of Motion (taught at key stage 3)

Explain to students that:
Sir Isaac Newton was a brilliant mathematician, astronomer and physicist who was one of the most influential figures in human history. Newton studied a wide variety of phenomena during his lifetime, one of which included the motion of objects and systems. Based on his observations he formulated Three Laws of Motion. Newton's First Law – An object at rest will remain at rest and an object in motion will remain in motion at a constant speed unless acted on by an unbalanced force (such as friction or gravity). This is also known as the law of inertia. Newton's Second Law – An object's acceleration is directly proportional to the net force acting on it and inversely proportional to its mass. The direction of the acceleration is in the direction of the applied net force. Newton's Second Law can be expressed as: F = ma. Newton's Third Law – For every action there is an equal and opposite reaction.

Materials

1. **CARDBOARD**
2. **SELLOTAPE**
3. **SCISSORS**
4. **EGG CARTON**
5. **PAPER**
6. **MARBLE** (OR MAKE YOUR OWN)
7. **CARDBOARD TUBES**
8. **FELT TIPS - TO DECORATE**

MAIN ACTIVITY

1. Students will need to work in a minimum of two for this activity.

2. Explain that students must develop a marble run from everyday items.

3. Ask students to develop a plan for their marble run. They will need to decide and agree on the materials they will use, write/draw their plan, and present their plan to the class.

4. Show students the student activity sheet and explain that they will need to follow the instructions to make their marble run.

5. Student groups next execute their plans and build their marble run using the materials they have chosen. They may need to rethink their plan, request other materials, or start again if the materials chosen are not working .

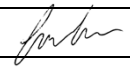
6. Next, teams will test their marble run. To ensure that the marble can travel from the top to the bottom.

7. Teams complete an evaluation / reflection worksheet, and present to the class.

PLENARY (QUESTIONS TO ASK STUDENTS)

1. **Did you succeed in creating a marble run?**
2. **Which materials did you use for your marble run?**
3. **How tall was your marble run?**
4. **How long did it take for your marble to go from the top to the bottom?**
5. **Did you decide to revise your original design or request additional materials while in the construction phase? Why?**
6. **If you could have had access to materials that were different than those provided, what would your team have requested? Why?**
7. **Do you think engineers have to adapt their original plans during the construction of systems or products? Why might they?**
8. **If you had to do it all over again, how would your planned design change? Why?**
9. **What designs or methods did you see other teams try that you thought worked well?**
10. **Do you think you would have been able to complete this project easier if you were working alone? Explain…**

STEM Day Risk Assessment

Risk Assessment for	Engineering at School Projects
Assessment undertaken on	31/03/2020
Assessment undertaken by	Jessica Lee
Signed	

No.	Activity/area being assessed	Associated risk	Who is at risk?	Existing control measures in place?	Level of risk (low, medium, high)	Responsibility
1	General Activity and Workspace	**Slips, trips and falls:** Injury due to tripping over items	Students and adults	Activity supervised by adult supervisor. Deliverer reminds students about safety in video introduction.	M	Students and adults
2	Use of Materials: paper/card, plastic containers	**Injuries:** Injury due to paper cuts, cuts from sharp edges **Injuries:** Injury due to misuse	Students and adults	Activity supervised by adult supervisor.	L	Students and adults
3	Use of materials: elastic bands, sellotape, glue stick, blu-tack, small toys, paper fasteners, LEGO pieces, nuts & bolts or equivalent.	**Injuries:** Injury due to use as a missile **Slips, trips and falls:** Injury due to slipping on dropped items **Injuries:** Ingestion risk of choking.	Students and adults Students and adults Students and adults	Activity supervised by adult supervisor. Activity supervised by adult supervisor. Activity supervised by adult supervisor.	L	Students and adults
4	Use of materials: plastic, corrugated carboard	**Injuries:** Cuts from sharp edges	Students and adults	Activity supervised by adult supervisor.	L	Students and adults

No.	Activity/area being assessed	Associated risk	Who is at risk?	Existing control measures in place?	Level of risk (low, medium, high)	Responsibility
5	Use of sharp tools: Scissors, craft knives	**Injuries:** Cut to self	Students	Activity supervised by adult supervisor.	M	Students and adults
		Behaviour: Cut to others	Students and adults	Activity supervised by adult supervisor.	L	Students and adults
		Behaviour: Vandalism of property	School or home	Activity supervised by adult supervisor.	L	Students and adults
6	Testing of projects: bathtub, drop from height, items on floor	**Spillage of water on floor**: damage and injury due to slip	Students and adults	Activity supervised by adult supervisor.	L	Students and adults
		Slip, trip or fall: Injury due to falling from testing area, tripping over items in testing space	Students and adults	Activity supervised by adult supervisor.	L	Students and adults

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The Marble Run Challenge

#EngineeringAtSchool

Suitable for ages:	Time needed:
5+	1hr+

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Dare to imagine

DESIGN A MARBLE RUN

You are a team of engineers who have been given the challenge to design your own marble run out of everyday items.

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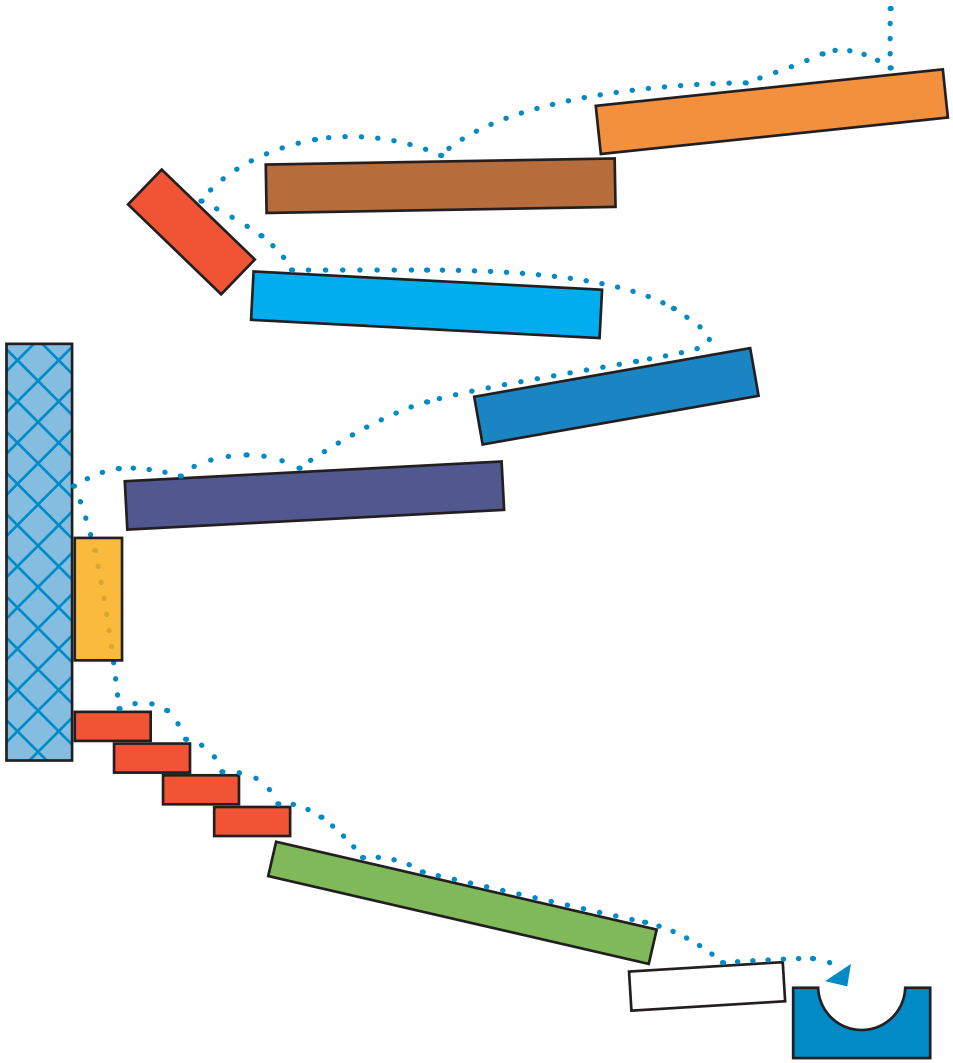
What is a Marble Run?

A toy consisting of a track with bends, obstacles, etc. that marbles can be made to run down using the force of gravity.



PLANNING STAGE

In your team, discuss the problem you need to solve. Then develop and agree on a design for your marble run. You'll need to decide and agree what materials you want to use.

Draw your design in the box below and label the different parts and materials you plan to use. Present your design to the class.

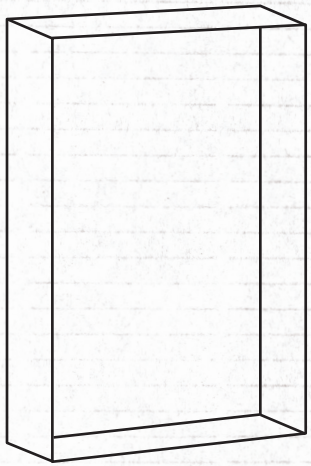
You may choose to revise your team's plan after you receive feedback from class.

MARBLE RUN DESIGN & MATERIALS

MATERIALS

1. **CARDBOARD**
2. **SELLOTAPE**
3. **SCISSORS**
4. **EGG CARTON**
5. **PAPER**
6. **MARBLE** (or make your own)
7. **CARDBOARD TUBES**
8. **FELT TIPS -** to decorate

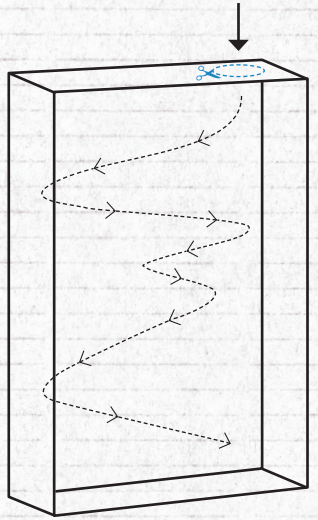
BUILDING STAGE 1 OF 2



1.

Find something to act as a backboard for your marble run – this can be as big or small as you would like.

Some good ideas are a cereal box or a shoe box lid, but any piece of cardboard will do.

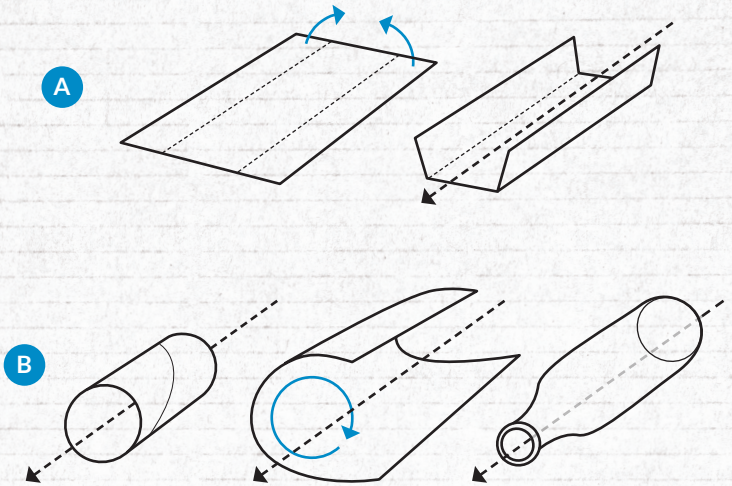


2.

If needed, cut an entrance for your marble to enter at the top.

Now design the route your marble will take.

You could trace out where you want your marble to go or freehand it.

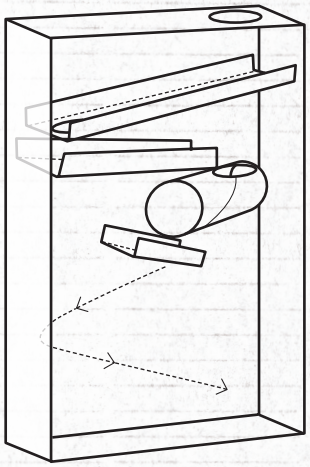


3.

There are many ways for your marble to make it to the bottom:

- **A** To make "steps", cut out a strip of cardboard, make sure it is wide enough to fold two tabs and for the marble to fit on. Fold the strip on both edges – one to stick to your backboard and use the other to keep the marble on course.
- **B** You could also use toilet roll tubes or roll paper tubes to make tunnels, or plastic bottles to act as a funnel. Just make sure your marble fits through these.

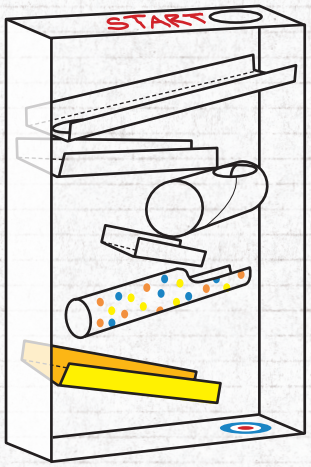
BUILDING STAGE 2 OF 2



4.

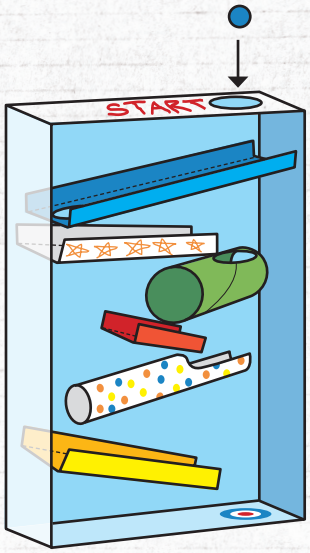
Stick your steps to your backboard.
The most important thing to remember is that they must be on an angle so that gravity can work on your marble.

Make sure to test that your marble follows the path as you are building.



5.

Decorate your design with felt tips or coloured card to make it stand out.



6.

Time to test your completed marble run!

TESTING STAGE

Each team will test their marble run. Change the height of your marble run to record the different results.

MARBLE RUN DATA

	Height	Time Travelled
Test 1		
Test 2		
Test 3		
Average		

EVALUATION STAGE 1 OF 2

Evaluate your team's results, complete the evaluation worksheet, and present your findings to the class.

Use this worksheet to evaluate your team's results in the Marble Run Challenge.

1. **Did you succeed in creating a marble run?**

2. **How tall was your marble run?**

3. **How long did it take for your marble to go from the top to the bottom?**

4. **What materials did you use to make you marble run and why?**

5. **Did you decide to revise your original design or request additional materials while in the construction phase? Why?**

6. **If you could have had access to materials that were different than those provided, what would your team have requested? Why?**

EVALUATION STAGE 2 OF 2

7. **Do you think engineers have to adapt their original plans during the construction of systems or products? Why might they?**

8. **If you had to do it all over again, how would your planned design change? Why?**

9. **What designs or methods did you see other teams try that you thought worked well?**

10. **Do you think you would have been able to complete this project easier if you were working alone? Explain…**

ADDITIONAL CHALLENGES

If you complete your marble run and want to challenge yourself further:

1. **Think about some real-life examples of how this science is used and create a design that mimics them. For example, you could make a rollercoaster or waterslide version.**
2. **Make another marble run and race your marbles to see which one is quickest.**
3. **Make two routes on the same backboard and time them or race them.**
4. **Create alternative routes by having a tab you can change to direct the marble a different way, like a train track.**
5. **Make a supersized one by joining multiple boxes together.**
6. **Decorate your marble run to make it stand out.**