

# GRAVITY

## **GRAVITY** The Challenge

Team Name: .....

Location : .....

Date : .....

Team Members :  
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# **GRAVITY** **The Challenge**

**Predict, Observe,  
Hypothesise, Experiment,  
Interpret, build a roller  
coaster, make a movie  
and compete for a prize.....**

Today, as a team, you will work together to carry out experiments, create a roller coaster and make a movie about your experience.

You will need to plan each of your activities carefully as there is limited time. Make sure you follow the instructions and complete the questions as you go along. It would be wise to read the Movie Challenge page next as you will need to include time for filming at each experiment.

You will be marked on your teamwork, planning, research and your final results. The winners from each day will be put forward to compete for the Ultimate Gravity Challenge Prizes which include iPod shuffles and Amazon Vouchers. The Tour finishes in March and it is hoped that a judges decision will be reached in April.

**Best Team**

**Best Advert**

**Best Movie**

**Fastest Roller Coaster**

**Most Inventive Roller Coaster**

**Best Workbook**

Good Luck!

# GRAVITY The Challenge

## The Scientific Method :

The scientific method is not a recipe: it requires intelligence, imagination, and creativity. It is also an ongoing process, constantly developing more useful, accurate and comprehensive models and methods.

A guideline for proceeding could be...

1. Define the question
2. Gather information and resources (observe)
3. Form a hypothesis. (What do you think will happen and why.)
4. Perform experiment and collect data
5. Analyze data
6. Interpret data and draw conclusions that perhaps serve as a starting point for new hypothesis
7. Submit results
8. Retest (frequently done by other scientists)

## The Rules :

Look after the equipment.

Leave all experiments as you found them.

Work together as a team.

Respect each others ideas and opinions.

Don't share your solutions with other teams until after the event.

Work tidily.

During the afternoon session you will be asked to pack the roller coaster away, please return it to box as you received it, counting and checking that all pieces have been returned... this also counts for points!

# SCP 1

## Super Complex Problem

One of the "hands on" experiments will help you solve this thought experiment. So think about it as you carry out all of the experiments and then complete the results section on this page.



# RESULTS

Your team have won a free stay at the Hilton Space Station. It has been explained to you that space travel is so uncomfortable you will have to be transported under general anesthesia.

Awakening on your back, you are thrilled to think you are in outer space, then you notice that your chair and writing desk are stuck to what would appear to be the ceiling. Or, could it be, that you are stuck to the ceiling and the furniture is where it is supposed to be?

You stand up feeling a little light-headed, but since you are staying on the "floor," you assume that gravity is behaving normally. You drop a marble and it falls to your feet. But then you toss some marbles upward, and depending on the strength of your toss, they either veer off and stick to one of the walls, or in some cases, stick to the "ceiling" (which is still supporting the furniture). Suddenly, you realize what is going on. To confirm your suspicions, you determine the exact centre of the room, and place a marble there. As you suspected, it stays put.

What have you proven?

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Which experiment demonstrates this effect?

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# GRAVITY

# The Challenge

# WATER

# DROP

## PREDICT

As the bottle drops, what will happen to the water coming out of the small side hole?

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## RESULTS

What did happen?

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Explain why this happened.

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Read all of the instructions and complete the prediction before doing the experiment!



You have a pool, a small water bottle with a hole in it's side and a large bottle with coloured water.

Carefully, keeping both bottles in the pool and with a finger over the hole in the small bottle, half fill the small bottle with the coloured water.

Now, when the camera person is ready, still with a finger over the hole, lift the bottle, with the other hand, as high as you can with the side hole pointing towards the centre of the pool... then drop the bottle into the pool so that it stays upright.

Check that you have caught what happened on the video camera.

Film the experiment once more and make sure you have caught all of the footage needed for your final film.

Now, transfer the movie from your camera to your computer. Go through the movie slowly dragging from frame to frame... what happened to the water coming out of the small side hole?

# LIFT the BALL

On the floor is a ball and a plastic container open end down.

Only touching the container and keeping it upright, lift the ball off the floor for at least 5 seconds.

Remember, you can't touch the ball with your hand, you can't tilt the container and you can't use anything else!

Make sure that you film your solution.

Don't tell the other teams how you solved this!

## SOLUTION

Explain your solution.

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Why do you think this works?

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## RESEARCH

Use the internet or books to help you. List the websites or books you used here:

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# BALL CANNON

You have a ball cannon, a target, a Ping Pong ball, a white plastic ball and a striped ball that has a rough surface texture and is slightly larger. The Ping Pong ball is half the weight of the other two balls.

Start with the light ping pong ball.

Keeping the ball cannon on the floor at all times, push the switch on the side to start and then, making sure that no one is in front of the cannon, carefully feed a ball between the rotating wheels.

Watch where the ball first lands and move the target there to mark the distance. Then try again with the same ball, move the target bin until you get the ball to land in it. Complete the Predict and Ball One questions before moving on to next stage.

## PREDICT

Compared to the ping pong ball, predict how far the plastic ball will travel through the air?

shorter

farther

Compared to the ping pong ball, predict how far the striped ball will travel through the air?

shorter

farther

## BALL ONE

Draw a simple diagram of the path (trajectory) that the ball takes through the air.

## TEST

Now, do one test with each of the other balls. Is your prediction correct? Fill in the boxes below with what actually happened.

plastic

striped

If one or both of your predictions was wrong, think why this might be and fill in below.

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# GRAVITY The Challenge

# LIGHT & HEAVY

## EXPERIMENT

You have a meter stick, two flasks with a LED, one heavy and one light, and a foam pad. One person holds the meter stick, another holds the light flask between thumb and forefinger, lining up the LED with the LED on the meter stick. When the camera person is ready and camera capturing, drop the flask onto the foam pad. Do again, to ensure you have suitable footage. Now repeat with the heavy flask.

Complete the predictions before moving onto next stage.

What should the acceleration due to gravity be?

Research using web if you don't know.

## PREDICT



The heavy flask will drop..

Faster

Slower

Same

From the movie captured, can you calculate the acceleration due to Gravity?

What do we know :

- 1) The camera runs at 25 frames/s
- 2) The starting velocity = 0 m/s
- 3) The meter stick has major divisions in cm.
- 4) Once imported into iMovie, you can scrub through the frames one by one.

Complete the results section. Use the back of the sheet for your calculations.

There is a help sheet available as a last resort.

## RESULTS

Acceleration due to gravity results :

Light

Heavy

Are your results as expected? If not, explain why this might be.

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# GRAVITY The Challenge



# SCP 2

## Super Complex Problem

**PROOF**

What does it prove? How?

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As far as we know, there are four fundamental forces of nature :

- 1) The Strong Nuclear Force :
- 2) The Weak Nuclear Force :
- 3) Electromagnetic Force :
- 4) Gravity :

It appears that gravity is the weakest of all the forces. Can you design a very simple experiment that you could do to show that it is weaker than one of the other forces?

**EXPERIMENT**

Describe your experiment :

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Hint :

Some of these might help :  
Balloon, magnet, paper,  
penny, nylon teddy bear, the  
Earth, air, crane, airplane...

### Four Fundamental Forces

- 1) **The Strong Nuclear Force** holds together the protons and neutrons that make up the atomic nucleus of atoms.
- 2) **The Weak Nuclear Force** causes the radioactive decay of certain atomic nuclei.
- 3) **The Electromagnetic Force** determines the ways in which electrically charged particles interact with each other and with magnetic fields.
- 4) **Gravity** is a force of attraction that acts between each and every particle in the Universe. It is always attractive, never repulsive. It pulls matter together, causes you to have a weight, apples to fall from trees, keeps the Moon in its orbit around the Earth, the planets confined in their orbits around their stars, and binds together galaxies in clusters.

**GRAVITY**  
**The Challenge**

# Roller Coaster Challenge

**Organise your team to complete the following within time.**

Within 75 minutes, a start height of 1.2m and using only 30 pieces of the 36 pieces of track provided, design a ball run that includes at least one loop and one 180 degree turn, additional points will be given for extra loops. Larger loops gain more points. A loop must be two full pieces of track or larger. At the end of the build time you have 5 runs and the ball must complete the course at least 2 times to score. You are aiming for the fastest run time. There are also points for invention and the most inventive roller coaster.

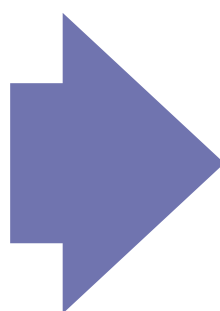
Before you start building read the rules and complete the Prediction sheet on the next pages.

Complete the Building and Timing page as you go along. Remember there are points for the best workbook!

Each team will be allocated a space to build the roller coaster, and a stack of chairs to use as a starting point. Think ahead and design your roller coaster so it does not conflict with others space, or essential passageways.

Make sure you capture some video for your final movie.

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**Best Team**

**Best Advert**

**Best Movie**

**Fastest Roller Coaster**

**Most Inventive Roller Coaster**

**Best Workbook**

# RULES

1. Max height of start point : 1.2m. It can be lower.
2. You can only use 30 of the 36 pieces of track.  
  
So you will need to choose to use more straight or more curved sections.
3. You need to include at least one complete loop.
4. The smallest a loop can be, is 24 cm and made of two pieces of track. See the side of this sheet. You can remove this sheet if it helps.
5. There are extra points for more loops.  
1 point for every 2 cm larger than 24 cm.
6. You must include at least one 180 degree curved section.
7. You must choose to use either the light ball or the heavy ball for your timed runs.
8. Out of 5 timed runs, your ball must complete the coaster at least 2 times.
9. If you need more supports, you can make others from any available materials, but ask your teacher first.
10. Look after the kit. Breakages or loss can be grounds for disqualification.
11. Use your imagination and enjoy!

**MINIMUM SIZE OF LOOP**

24 cm Size of smallest loop. Measure from top edge of sheet to line

24cm  
size of  
smallest loop

26 cm

28 cm

# PREDICT

You have a choice of two balls which have different masses, predict which ball will :

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- a) Complete the run fastest : heavy or light?

Why?

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- b) Stay on the track best : heavy or light ?

Why?

- c) Which ball will be best for this challenge?

Why?

- d) You have a choice of straight or curved sections of track which will allow you to achieve the fastest time.

Why?

# BUILD

a) What determines the max size of loop possible?

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b) How could you improve cornering?

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c) What part does gravity play?

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d) Which ball has proved to be better for your ball run and why?

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e) Comment on your predictions.

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# TIME

Do five timed runs. Your ball must complete the course 2 times to count.

How could we improve the accuracy of our timing?

Insert best times in seconds

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# MovieChallenge



Using the footage captured from the Experiments and the Roller Coaster organise your team to complete both of the following movie challenges :

## Challenge One

Create a 30 second TV advert that either :

- a) captures the spirit of today's challenges.
- or
- b) promotes your roller coaster.

## Challenge Two

Create a 2 minute documentary movie to explain one of the experiments and what you have learned.

Think again about the experiments. Do any help explain how the ball behaves on the roller coaster? If so, then use this in your movie. Try and explain one of the experiments fully.

Your movie should not only cover your successes, but any problems you found and how you solved them. You can shoot extra footage and do voice-overs as required. You can also create graphics or simple animations and use these. But remember, your movie must only be up to 2 minutes long.

Beware of using copyright materials, movies, pictures or music, as this will result in disqualification.

## Your Camera Shots

If possible, use a mix of wide, mid and close up shots to help make your movie more interesting. Panning or moving the camera is difficult to do well, so either practice or probably best to avoid.

## Plan Your Movie

Create a storyboard and plan any extra shots you will need. Think about transitions and any effects you might want to add.

Write a simple script for any voice over sections you might want to add.

Come up with a title and add credits.

Garageband is good for creating music.



# MovieChallenge

TEAM

LOCATION

TITLE

DATE

NOTES

PAGE





# Notes: