Gravity Discovery Centre

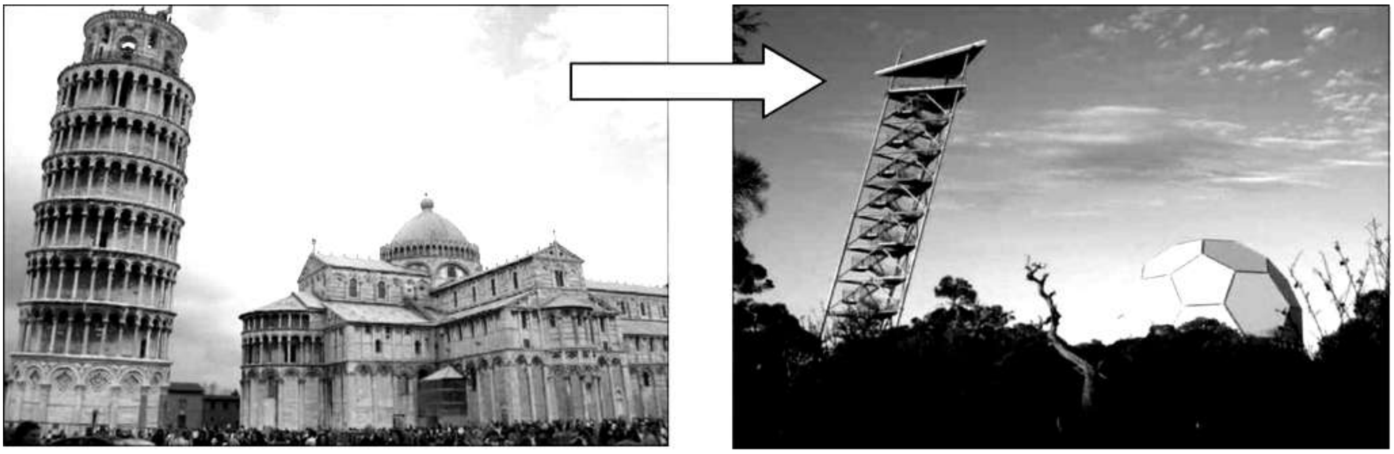
Exhibit 24

Name : Leaning Tower of Gingin

Supplied Equipment:
- Water balloons
- Entry token

Your own Equipment:
- Bucket to carry water balloons
- Polystyrene cups
- Stopwatch
- Kitchen scales
- Calculator
- This booklet

Introduction:



This is the world's most leaning tower at 15 degrees and 180 tonne.
The tower has 222 steps to the highest observation platform at 40m and to the roof is 45m.

Galileo was a student in Pisa about 440 years ago. Before Galileo, in about 350BC, the ancient Greek philosopher Aristotle said "things fall faster if they are heavier" and everybody believed him. Galileo was the first person to say *"Let's not just believe what the ancients told us. Let's try it out."*

As a student Galileo probably dropped things off the Leaning Tower. What might he have dropped? Apples, melons, stones, blocks of wood, bricks?

No one knows because he didn't tell anyone. This is what he did say: *"If you were to drop two weights from the Leaning Tower of Pisa and if they landed within 2 fingers widths of each other, then would you still believe what the ancient philosophers said"?*

Today we know that Galileo was right. Everything **does** fall at the same speed except for wind resistance. Space satellites are falling in a circle, and astronauts float around freely inside the Space Station because they are falling at the same speed as the space station.

Safety
DROP only water balloons

If anything is dropped or thrown, the tower will be evacuated.
Look out for students in your team who might be uncomfortable about heights and climbing and assign them to the observing team.
If anyone starts feeling faint or dizzy or uncomfortable after they have started their climb, sit down and wait for an adult to assist.
Drop balloons after a loud countdown at the top of tower. This is necessary to prepare Observers to be watching, and for others to be prepared for the loud THUMP!

Activity

Students will drop varying sizes (shape and weight) of water balloons, observe and compare rates of fall and see craters being formed.

In your group you will need two "droppers" and two "observers"

The tower group will fill their water balloons at the tap. These can then be weighed and recorded.

One group remains at the bottom as the observer group. The other group ascends with their balloons in a bucket.

At the top, one student drops two balloons at once.

At the bottom, the observer group is responsible for recording observations by eye and / or with digital cameras.

At the end the groups swap.

Points for Observer Group

Observers observe and listen for the double thump when one mass is ahead of the other. Other observations can be recorded.

Recording with Digital Cameras: It is best if the camera has a sports/action setting for fast moving objects.

Questions

Did you manage to get two balloons to "*land within 2 fingers widths of each other"* Explain

Do big balloons or small balloons fall fastest? Why?

Add air to balloons so they all have the same size but different masses (amount of water). What did you see for these?

Impact Craters.
Explain how they are created.

Draw a crater – they are the same as meteor craters?

Holey Cup Free Fall Investigation
If you have a polystyrene cup with a hole in the bottom, does the water fall out as it falls?

Gravity Discovery Centre

Exhibit 6

Name: The Gravity Wave Interferometer model

Supplied Equipment:

- Interferometer

Your own Equipment:

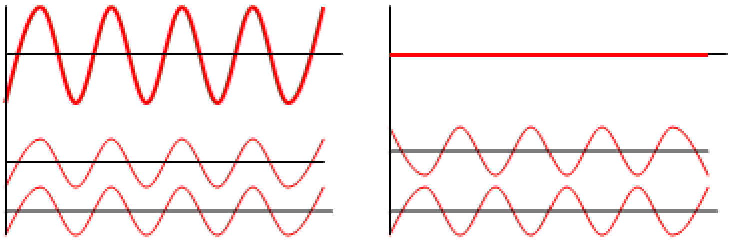
- This booklet

Introduction:

Gravitational waves shrink one direction of space while they stretch the other. The best way we know of measuring this type of motion is by sending laser beams down two vacuum tunnels arranged in an L-shape.

At the end of the tunnels the light reflects back from carefully suspended mirrors. All the parts are carefully isolated against the vibrations of the ground, which are billions of times larger than the motion caused by gravitational waves.

When the laser beams re-bound, they are combined in the same half silvered mirror that originally split the beam. When the light waves of the laser beams combine they may add up to make bright light, or vibrate in opposite directions to cancel each other out.



Constructive Interference Destructive Interference

This process is called interference, and the device that does it is called an interferometer. (if you have a special interest in this technology, ask receptionist to view the movie).

The Task:

You will see on the screen before you the pattern that has been generated. There are bright ark and light patterns. This is an example of constructive inference.

If you stamp your feet on the floor you will see the bright and dark band disappear. This has not become destructive interference.

The display users a laser because it has a special kind of light. All the rays are moving together [in phase] and are going the same way. Ordinary light has jumbled rays and so will not construct or destruct.

This particular laser has a wavelength of 232nm or 232 x 10^{-9}m.

How much did the concrete floor move when you stamped on it?

If the velocity of light is 299,792,458 m/s and each wave is 232nm how many waves go by every second? In other words what is the frequency of the green laser light?

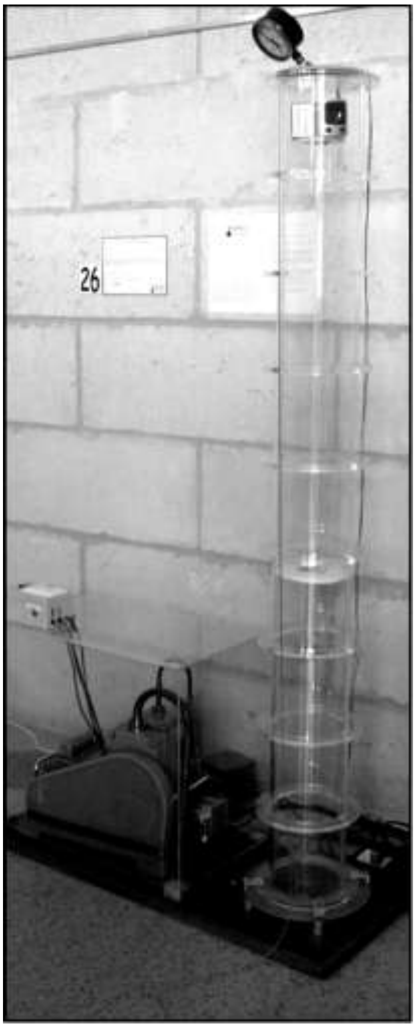
Exhibit 26

Name: The Vacuum Parachute

Supplied Equipment:
- Magnetic car
- Inclined plane with various metal plates on it

Your own Equipment:
- Tape measure
- Stopwatch
- Protractor
- Calculator
- This booklet

Introduction:



This is really useful in proving that a parachute will fall faster through a vacuum and sound will not travel through a vacuum.

The plastic parachute has a magnet which, by dropping the string magnet, connecting to the chute and slowly pulling to the top, it will release and fall gently to the bottom. By pressing the sound button, the siren is distinctively heard through the tube.

By turning on the pump (pump button located on control box), leave the pump on until the cylinder is fully evacuated (-100 kpa - the gauge mounted on top of the tube will indicate when vacuum is fully reached), turn off the pump, then pull the parachute up and release it again, notice how quickly it drops now, (in comparison to the slow decent with air in the tube).

Now press the sound button and the siren is barely audible. This proves that sound will not travel through a vacuum. The pump will only achieve a 99% evacuation, this is why a faint sound can still be heard.

The Task:

Record the drop time for the parachute before you begin pumping out the air

Time

As the tube is evacuating record the amount of vacuum [as negative pressure] and estimate how the siren sound is changing.

If you were to draw a graph of sound intensity vs vacuum what shape graph would you draw?

Can you suggest a reason for obtaining this shaped graph?

Now you have established a vacuum, record the parachute drop time again. Comment on your result.

On May 25th 1977 George Lucas released the first of the Star Wars movies. He always had a problem of what sound effects to offer when spacecraft exploded and the “Death Star” destroyed planets. What would you advise?

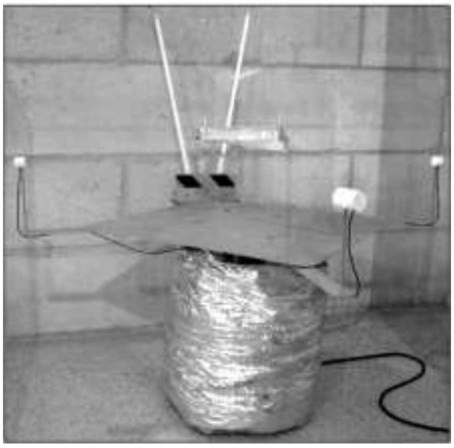
Gravity Discovery Centre

Exhibit 24

Name: Ion Drive

Supplied Equipment:
- Ion drive

Your own Equipment:
- calculator
- This booklet



Introduction:
The second anti-gravity exhibit is an ion engine. Ion engines have been around in science fiction for years as a way we might send spaceships to the stars.

Today at last they are being tested in space. Most rockets send out a jet of hot gas from burning chemicals. An ion engine instead sends very fast ionized atoms out of the thrust exhaust. It is an all-electric rocket with no moving parts.

The ion drive allows you to fly a small craft up in the air. Ions are electrically charged atoms. A very high voltage strips electrons from atoms in the air, the -ve charge is created along the edge of the foil. The ions are accelerated downwards, thus creating a lift force which lifts the craft upwards.

Because the ions are very light, ion engines need very little fuel, but they do need electric power. See the poster about propulsion craft and deep space.

The Task:

You will need some data from the poster to your right.

Thrust 3g. Using F=ma we can se it is therefore producing a Force of 0.003 x 9.8 = 0.0294 So the ion drive is producing a force of 0.0294 Newtons

The only spacecraft to leave the solar system has been the Voyager unmanned craft that were launched in 1977. They each had a mass of 815kg.

They are travelling at 62,764 km/hr.

In future similar craft would be assembled at the space station and using an ion drive would be sent off to deep space.

A few formulae;
Force = Mass x Acceleration
Velocity = acceleration x time

Using F = ma, if our ion drive is producing a force [F] of 0.0294 Newtons what acceleration [a] will it provide for an 815kg [m] space craft?

Using Velocity = acceleration x time [v = at]
If we are to accelerate this craft to 62,764 km/hr [17434m/s] how long would it take to reach this speed?

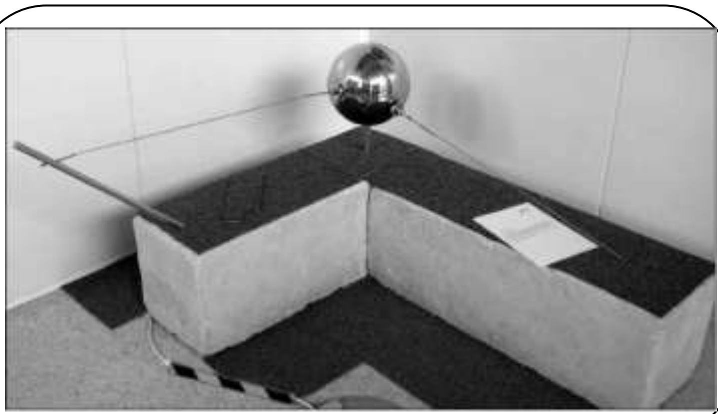
Comment on your answer

Research

Could we accelerate it all the way up to the speed of light?

Exhibit 13 and 38

Name: Magnetic Force Ball and Magnetic Levitation



Supplied Equipment:
- Magnetic force ball
- Magnetic levitation

Your own Equipment:
- This booklet

Introduction:

Exhibit 13
This exhibit lets us experience the force of magnetism. Hidden magnets attract iron masses to the ball. You can feel the force by pulling the hovering magnets.

The mysterious attraction you feel results from all the atoms in the material being aligned, and each atom itself being a tiny magnet created by electrons moving in orbits.

Our super magnets are made from the elements neodymium, iron and boron. Magnets never run down...they go on forever as long as their atoms stay aligned.

Please return the masses to their hovering position.

Exhibit 38
Unfortunately Physics tells us that antigravity is impossible.

Of the four forces that shape the universe, “Gravity” always attracts. All we can do is oppose gravity with other forces. Our bodies constantly defy gravity by exerting forces: legs and chairs and tables are antigravity machines.

Our magnetic levitator defies gravity by using an electromagnet to hold up a very strong magnet. The trick is to keep it stable and to do it without using too much energy.

This is the closest we can get to the “Anti-Gravity” we see in Star Wars movies.

The Task:

On exhibit 38 start the suspended magnet spinning and observe the result.

Suggest what practical purpose we could find to use these effects.