Gravity Discovery Centre

Exhibit 37

Name: Space Junk and Meteors

Supplied Equipment:

- A meteor
- An oxygen tank

Your own Equipment:

- This booklet

Introduction:

Mandrabilla Meteorite (Exhibit 36)
Found in the Nullarbor of Western Australia this 300 kilogram mass is one of a large shower totalling more than 22 tones found on the Nullarbor. This meteorite may have fallen to Earth over a million years ago and the pitted surface is from prolong weathering. The main elements of this meteorite is Iron and Nickel.

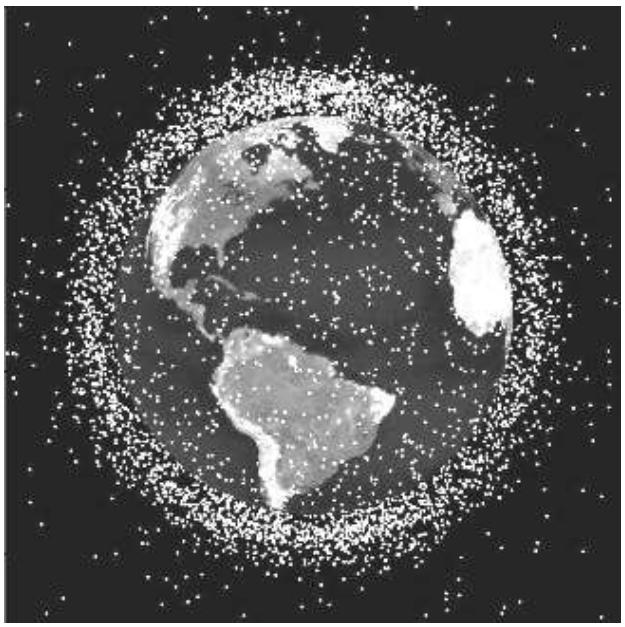
Sky-Lab Oxygen tank (exhibit 37)
Here is part of an Oxygen tank (one of six) that re-entered the Earth's atmosphere and fell to Earth near Esperance in Western Australia. There were 4 others found, scattered across the Nullarbor plains. A cow was killed by one, and a rabbit was found under another, luckily no other life was lost. The tank is made from Titanium and Carbon fiber.

In early 2009, a U.S. commercial satellite and an old Russian satellite smacked head-on in outer space. The violent collision sent thousands of pieces of new space junk flying off in all directions. The debris, which could threaten spacecraft or other satellites for up to 10,000 years, raises the alarm about the growing danger of space junk.

There's already lots of space junk up there. Out of nearly 20,000 objects orbiting Earth that are big enough to show up on radar, only 900 are satellites. The others are trash. On top of that, there may be 300,000 other objects too small (less than 10 cm) for radar to see.

Space junk is already causing problems. Space shuttle astronauts notice holes on satellites they work on in space. The holes are from high-speed collisions with tiny bits of debris.

Scientists are having a tough time figuring out what to do about the problem. One idea is to attach balloons to low-orbit junk to increase atmospheric drag so the pieces will fall to Earth faster. Even more out of the box is the idea to attach an electrodynamic wire to space trash to generate electric current controlled from the ground. Neither these nor any other ideas suggested so far are practical or affordable.



In the meantime, scientists hope nations of the world will get better at pooling radar data showing where the space junk is. This should at least improve the odds that spacecraft can dodge the most dangerous chunks.

The Task:

The diagram of space junk on the previous page shows something interesting. Most of it is at the same height above the earth.

There are preferred heights for satellites.
For example if a satellite is to remain over Perth at all times there is only one place it can be.

Let's see how it works…it's a bit complicated so you can skip over the following box if you want.

To stay up there and not drift out into space it needs to be pulled in by a centripetal force. This is determined by a=acceleration, v=velocity, r = radius of revolution.

$$a = \frac{v^2}{r}$$

As velocity is found by s=distance / t = time

$$v = \frac{s}{t}$$

And the distance [s] is the circumference of the orbit

$$c = 2\pi\, r$$

We put them together and get

$$a = \frac{(2\pi r)^2}{r t^2}$$

The gravitational field of the earth is the acceleration used to do this so we have an equation for gravitational acceleration.

$$g = G\frac{m_e}{r^2}$$

We can equate g and a and simplify to get a cube root expression;

$$r = \sqrt[3]{\frac{G m_e t^2}{4\pi^2}}$$

If G = 6.67 x 10^{-11}, and the mass of the earth is 5.9742 × 10^{24} kg and t = 24 hours [convert to seconds] you can find the height of the space junk.

How far above your head is the junk if the radius of the earth is 6357km?

What is major problem of space junk and what would you recommend we do about space junk?

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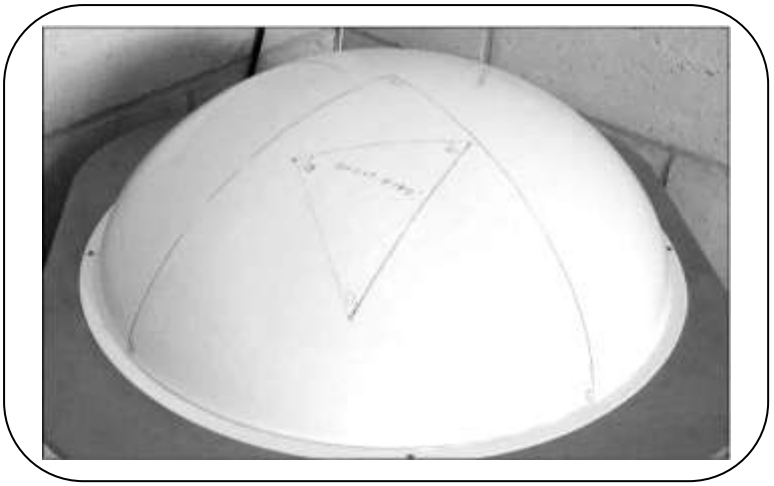
Exhibit 10 and 19



Name: Curved Space

Supplied Equipment:

- Plastic dome

Your own Equipment:

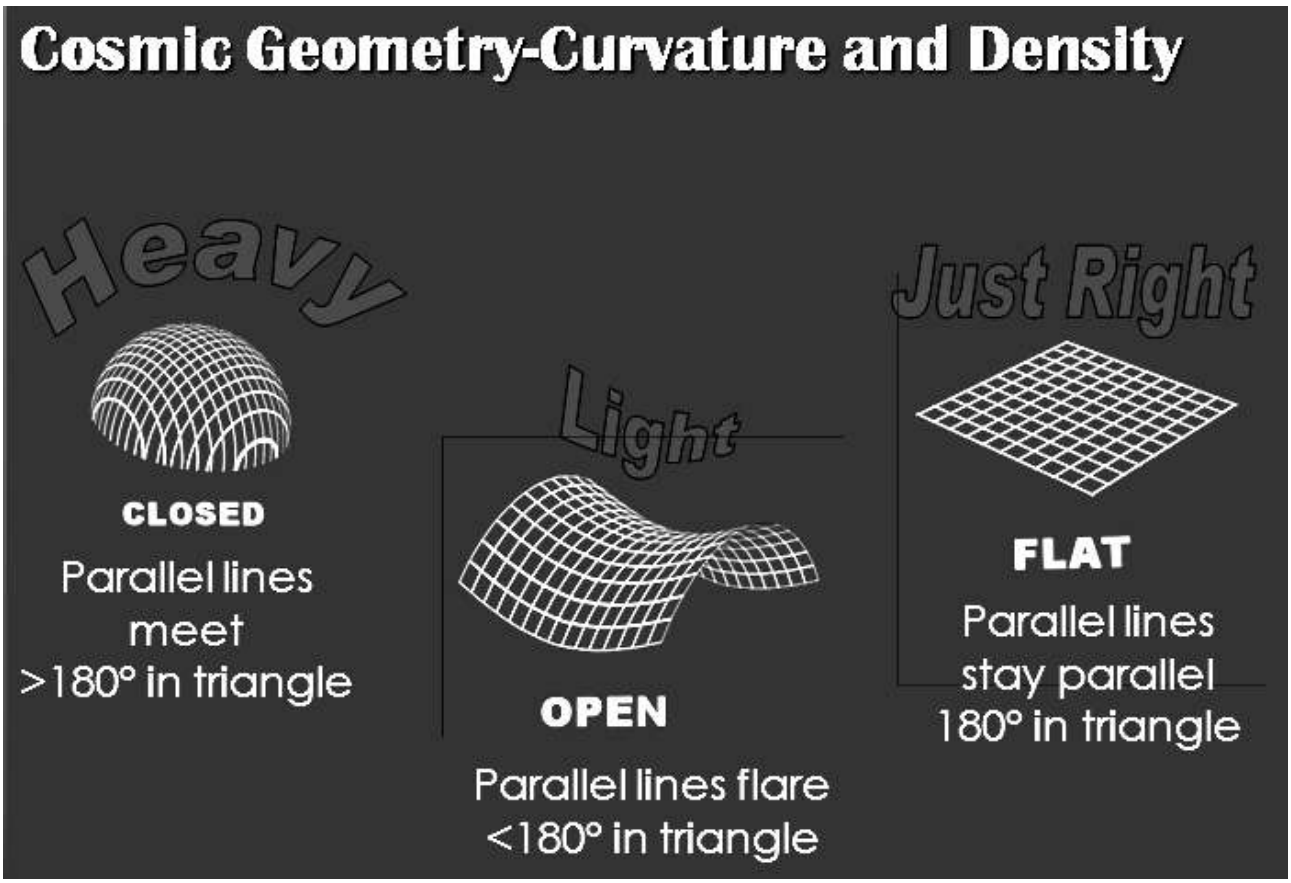
- Whiteboard marker
- Glass cleaner to clean dome after
- Protractor
- Calculator
- This booklet

Introduction:

This allows you to investigate geometry on curved space.

There has been discussion since the time of Einstein as to what shape space takes. Is if flat or curved in some way?

The suggestions are here.



If we take measurements between three objects in space the number of degrees in the triangle will tell us the shape of space.

Everyone knows how to draw triangles on a flat piece of paper. At school we learn what Euclid of Alexandria, [a Greek mathematician - the Father of Geometry] taught from 323 BC – 283 BC that: the sum of the angles of a triangle add to 180 degrees.

On the curved surface of the dome draw a line up from the equator to the North Pole.

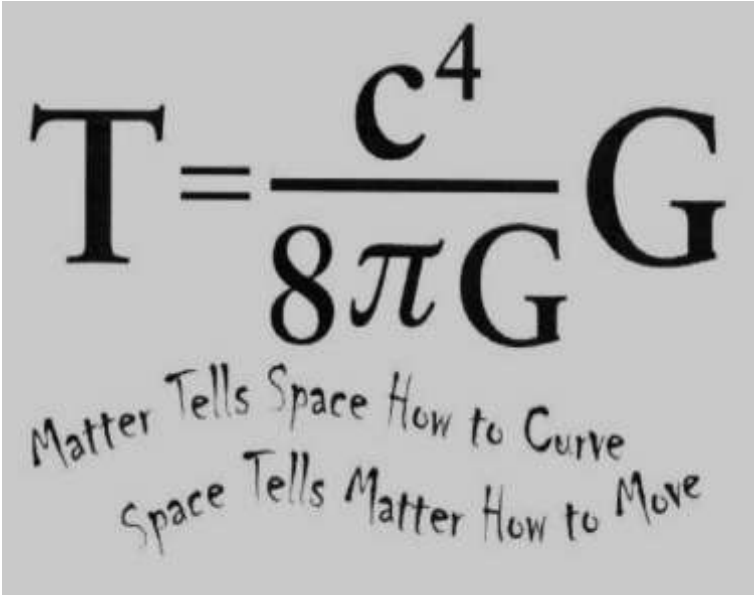
From the north pole go around 90 degrees and draw down to the equator.

Join your two equatorial points.

Your triangle drawn from the equator to the pole has three angles of 90 degrees, the total sum of this triangle being 270 degrees, this is much more than the 180 degree law that we learnt at school.

Where ever there's matter, space is curved. This means that everywhere in the Universe shapes are distorted and because of these rules, some of the Geometry learnt at school is incorrect.

How many degrees in a triangle in a saddle shaped Universe?



Einstein's Equations of gravity and Space (Exhibit 19)

The History of the Universe is the history of expanding space. The weird concept of space being able to expand, flex, and bend was introduced by Einstein in his equations of space and gravity, which are illustrated on the end wall. Don't worry about the symbols because it is described in the words below:

"Matter tells space how to curve, space tells matter how to move".

Almost all our knowledge of space and gravity is contained in that one equation. The capital T stands for Mass and Energy, the big capital G describes the curvature of Space. they are linked by an enormous number made up of the speed of light multiplied by itself 4 times, that most mysterious of all numbers, Pi, and Newton's constant of gravitation, the small capital G. Mass and Energy are themselves unified by Einstein's other equation $E=mc^2$.

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Exhibit 12

Name: Magnetic Spring

Supplied Equipment:

- Magnetic spring apparatus

Your own Equipment:

- Calculator
- Tape measure
- Spring balance
- This booklet

Introduction:

Feel the tension in the magnetic spring. The ring magnets are placed alternately north to north and south to south so that they all repel each other. The magnets are supported in line by a magnetic force in much the same way that atoms are supported inside solid materials by the electrical forces between them.

The Task:

Play with this piece of apparatus.

Using a spring balance find a way to measure the force required to compress the magnets different distances.

Construct a graph of compression vs force

What conclusions can you draw from the above graph?

Suggest a use to which this apparatus could be put.

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Exhibit 5

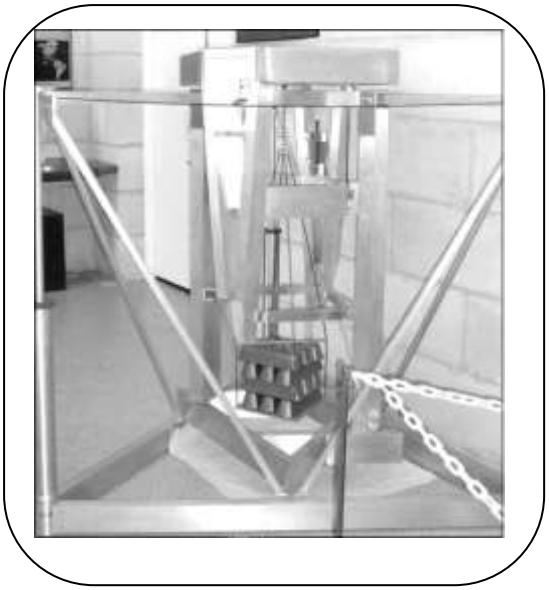
Name: Vibration Isolator

Supplied Equipment:

- Vibration free machine

Your own Equipment:

- This booklet



Introduction:

To detect the vibrations of Gravity waves you first have to eliminate the vibrations from the Earth. The ground under your feet is vibrating about a millionth of a metre. When you walk over a solid concrete floor you sink into it by about the same amount...as if you were walking on a trampoline.

The best way to isolate things from vibrations is with springs and pendulums. To work extremely well the pendulums need to be very long. It would be best if they were a kilometre long...taller than the tallest building.

Physicists in Western Australia have found out how to make synthetic pendulums that act as if they are a kilometre long even though their real length is only a metre.

This proto-type exhibit is called a Scott-Russell isolator. It is based on a mechanical linkage developed for steam engines. This particular piece of equipment has the world record for the longest synthetic pendulum. It reduces vibration energy about one hundred thousand times.

The Task:

You will need to get down on your hands and knees to look at this amazing machine. How does it work? Sketches and a description would be great.

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Exhibit: Cosmology Building

Name: Penrose Tiling

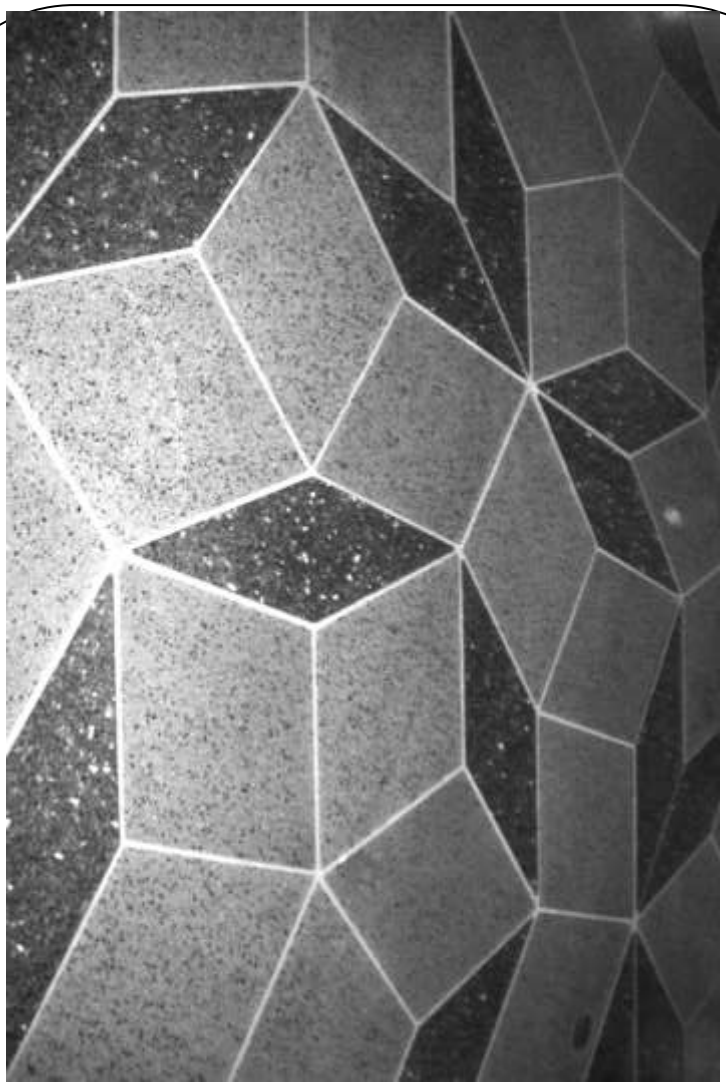
Supplied Equipment:

- Tiling on the floor

Your own Equipment:

- This booklet

Introduction:



First observe The floor Tiling, This is called “Penrose Tiling".

"The mathematical equation on this type of Geometric configuration was first originated by the early Egyptians before Christ".

"Unfortunately they could never solve the equation. It was eventually solved by the mathematician, Rodger Penrose, in 1974".

"Here we have two basic tile shapes, that can form sixty seven different patterns, several patterns of which can be seen in the floor here, increasing tile colour variations can also increase patterns, even third dimensional patterns can be noticed on this floor".

The Task:

This is a great example of Tessellations which you have done in Maths.

Make a sketch of the repeating unit used to generate the pattern