Teacher Resource Pack: Year 7/8

Introduction

In this package are Australian Curriculum links, teacher resources, lesson ideas and supplementary materials. It is recommended for teachers to use this package to supplement teaching in Science/Earth and Space. A school excursion to the Gravity Discovery Centre is also recommended to create the most impact for students.

Australian Curriculum Achievement Standard **(by the end of year 7):**

Students describe techniques to separate pure substances from mixtures. <u>They represent and predict the effects of unbalanced forces, including Earth's gravity, on motion. They explain how the relative positions of the Earth, sun and moon affect phenomena on Earth.</u> They analyse how the sustainable use of resources depends on the way they are formed and cycle through Earth systems. They predict the effect of environmental changes on feeding relationships and classify and organise diverse organisms based on observable differences. Students describe situations where scientific knowledge from different science disciplines has been used to solve a real-world problem. They explain how the solution was viewed by, and impacted on, different groups in society.

Students identify questions that can be investigated scientifically. They plan fair experimental methods, identifying variables to be changed and measured. They select equipment that improves fairness and accuracy and describe how they considered safety. Students draw on evidence to support their conclusions. They summarise data from different sources, describe trends and refer to the quality of their data when suggesting improvements to their methods. They communicate their ideas, methods and findings using scientific language and appropriate representations.

GDC Education Program year 7/8

Exploring gravity in the Solar System

Gravity Discovery Centre offers a unique science education program unavailable elsewhere. Education programs focus on all three strands of the Australian Curriculum in Science. Students in year 7 and 8 explore how gravity influences the Earth, the Solar System and beyond. Students have the opportunity to test theories and experiment, develop their understandings in Earth and Space, and discover the stories of human endeavour which contribute to our current understandings of the Universe. They will be challenged to evaluate how humans think about the Universe, and encouraged to develop their own understandings and ideas.

Student Activity Pack

The student activity pack for year 7, 8 contains useful activity sheets for use during an excursion**,** and in the classroom. Student responses may be used as assessment material. It is suggested that teachers print student copies to bring on their GDC excursion. Student Activity Packs are available on the GDC website.

Assessment

Assessment ideas are contained in lessons below. *Gravity Questions* and *Assessment Questions* may also be used.

Lesson 1: What is Gravity?

Discussion question: Why does a ball fall when it's dropped?

Possible strategies for pre-visit discussion:

- Think, Pair, Share followed by teacher led discussion
- A concept map for falling objects. This could be developed by each group, or could be developed on the whiteboard as a whole group through input from group discussion.
- A KWL chart about falling objects. They could be developed by individual students, groups, or could be done as a teacher led discussion.

Guided questioning:

There are a range of levels of student responses and understandings for the above question that can be drawn out through careful questioning.

Question	***Possible response and discussion***
Why does a ball fall when it's dropped?	*The ball falls down because I let it go.* This describes their observation of what they did and shows no conceptual understanding.
Why does it fall **down**?	*Because all things fall down when we let them go.* Again, just summarising an observable generalisation.
What do you mean by **fall**?	*It is pulled towards the Earth*. This indicates the idea of a force 'pulling' the ball and the Earth as the thing that 'pulls'. Depending on the level of students, the word force could be introduced as a scientific way of describing the 'pull'.
Is **everything** pulled towards the Earth? Or, do all things have a pulling force on them caused by the Earth?	*Yes* Students could raise questions about a feather when it is dropped, a helium (party) balloon when it is let go, why a plane doesn't fall, why a kite stays in the air, or why the Moon goes around the Earth. These could be included in the W part of their KWL chart. Or, students could be challenged by demonstrating 'dropping' a feather and a helium balloon. Are these pulled towards Earth at the same rate as the ball? Students could work in groups to come up with their own response to this question for the examples raised or demonstrated. Rather than give explanations at this stage, teachers could make the point that this is real science – asking questions, thinking of possible explanations and then investigating their ideas by experimentation to get evidence. **Now it's time to go to the GDC to investigate!**

Lesson 2: Post-investigation

(at the GDC or back at school)

<table>
<tr><th>Question</th><th>Discussion</th></tr>
<tr><td>Does the Earth always pull (exert a force) on an objects such as a ball?

What about when a ball is sitting on a table, or thrown up? Is there always a pull or force on the ball? How do you know?</td><td>Students could be asked to draw each of these situations using an arrow to show where there is a pull, and which way it is being pulled. Whole group discussion could show these on a whiteboard.

As an elaboration of this concept, an envoy strategy could be used where each group is given a photo (or diagram) of a different situation and asked ‘draw arrows to show all the pushes or pulls (forces) on the object?’ For example, a basketballer just after leaping off the ground, a golf ball after being hit off the tee, a gumnut hanging on a tree branch, a cup sitting on the table, a parachutist.
Students often think that there is only a pull (force) on the ball when it is actually falling downwards, not when it is slowing down while going up or when it is not moving.</td></tr>
<tr><td colspan="2">Key idea: The force (pull) of gravity is always acting downwards on an object, regardless of whether it is travelling up, down, sideways, or is stationary.</td></tr>
<tr><td>Why do some things stay stationary, even though the pull (force) of gravity is pulling it towards the Earth?</td><td>They can be guided towards an understanding of other forces (pushes or pulls) on an object that can stop it from moving, cause it to accelerate, or slow it down. This is a much higher conceptual level.</td></tr>
<tr><td colspan="2">Key idea: Different forces acting on objects can result in:

‘balanced’ forces. The object will:
remain stationary, such the cup sitting on the table;
move at a constant speed, such as a person falling with a parachute.
‘unbalanced’ forces. The object will:
accelerate (get faster), such as the ball dropping towards the Earth, or
decelerate (get slower) such as when the basketballer is jumping up.
</td></tr>
<tr><td colspan="2">Activity: In groups show and describe another example of each of the above situations (balanced and unbalanced forces acting on objects). Each group could demonstrate their example to the whole class and the examples could be detailed on the whiteboard.</td></tr>
</table>

Lesson 3: Gravity questions

(Following your GDC excursion)

1. Find out

1.1. What are the dimensions of the Leaning tower of Gingin and the Leaning Tower of Pisa?
1.2. How was Galileo's method of science different to thinkers such as Aristotle?
1.3. When did Galileo perform his experiments investigating gravity?
1.4. What other types of experiments did he perform?
1.5. What aspects of gravity were his experiments investigating?

2. Think about

2.1. What is gravity?
2.2. How can we measure its strength?
2.3. Can you design experiments that will allow you to determine the effect of gravity on objects falling from the top of the tower?
2.4. What variables will be involved in your experiments?
2.5. Did all of your objects fall the same?
2.6. What is the most appropriate way to present your observations and data?
2.7. Can you use the terms speed, velocity, acceleration, mass and force to explain your observations?
2.8. What does it mean when astronauts experience "g" forces during lift-off?

3. Apply and extend

3.1. Can you calculate the height of the tower from your experimental results?
3.2. Can you describe any quantitative relationships that you have observed in your experiments?
3.3. After performing you experiments and observing the exhibits at the GDC, can you explain what causes object to "fall" from the tower?
3.4. If Newton was correct in describing terrestrial forces such as those that make apples fall as being the same as celestial forces like those that make planters orbit, why did Einstein describe gravity differently?
3.5. What exactly are researchers investigating at the AIGO?

Research Question

Why is Aristotle regarded as a philosopher and Galileo a scientist?

Expected answers

1. Find out

1.1. Gingin Tower: 45m, 15-degree lean, 222 steps. Pisa Tower: 55.9m, 3.99degress, 300 steps.
1.2. Galileo used the scientific method (i.e.) he performed experiments investigating the rate of fall of object
1.3. Between 1589 and 1592 (but probably not by dropping things from the Leaning Tower of Pisa).
1.4. He measured the rate of change of position of balls rolling down inclines and the effect of viscosity (air resistance).
1.5. He believed that the rate at which objects fall is independent of their mass.

2. Think about

2.1. Newton said gravity is a force that exists between all masses in the universe and is proportional to the size of their mass and inversely proportional to the square of the distance between them.
2.2. He also said that F=ma (Force = mass x acceleration), so any experiment that measures acceleration of a mass will be able to determine the size of the force.
2.3. Explore what happens to water in a cup, the relationship of object mass to crater size, surface area (balloon size) to mass
2.4. Some variables involved are mass, surface area, time and displacement. These are used to determine acceleration and force.
2.5. Air resistance, human response times and observations will be factors contributing to results variations.
2.6. Charts, graphs, lists of data, sentences or essay
2.7. Explain definitions and their uses in formula
2.8. The acceleration of a rocket is usually 3 or 4 times greater than the acceleration of a falling object (gravity) "g".

3. Apply and extend

3.1. Calculate the height of the tower from the time it takes your balloons to drop. (Hint: use $s = \frac{1}{2} at_2$). Compare your calculated value to the actual value. How accurate was your calculation?
3.2. Examples could be: relationship between time and speed/velocity of falling balloon; time and distance/displacement of falling balloon
3.3. Gravity is not an instantaneous force that pulls object together – rather it is that mass causes space to curve and other masses follow this curvature in space.
3.4. The differences between Newtonian Gravity and Einstein's theory of relativity.
3.5. AIGO is investigating ripples (gravity waves) in space travelling at the velocity of light, caused by massive disturbances like black-hole collisions.

Lesson 4: Making a model Solar System

Model Solar System pre-test and post-test

Equipment:
Play dough, rulers, digital camera, icy pole sticks, textas

Instructions:
Divide students into small groups. Provide adequate table space, ruler, icy pole sticks, texta and a sizable piece of play dough.

Task:
Each group is to make a model scale solar system on the table using play dough. Students should represent the size of planets and distance of planets from the sun as accurately as possible using their current understandings. Students should agree on an approximate scale for their model. The model should begin with the sun and show planets in order. Moons and the asteroid belt can be added if understanding exists.

Assessment:
Take digital photos of the group models as **pre-assessment** tool. Following the group exercise in lesson 5, repeat the above task as a **post-assessment** tool.

Wrap up:
Allow students to view other groups' models. Facilitate a classroom discussion about differences in models and how they could be improved. Explain to students that in the next lesson you will be making an accurate scale model of the Solar System.

Lesson 5: Making the model Solar System

How to design a Solar System scale model

Equipment:
School oval, tape measure (trundle wheel), plastic cones or wooden markers, glue, tape, paper/card

Instructions:
Outside, space out approximately 100m section of grass/oval. Place your sun at one end (represented by a large beach ball perhaps). Pace out or measure the distance of each planet from the sun and set the marker down at each measurement. Use the table below. Be aware that on this scale the true size of some planets is so small that they would be barely visible. The Earth would be a very small speck. In order to make this demonstration more visual for students we have multiplied planet sizes by a factor of 10. Even at this scale Earth is 2mm in diameter, and Jupiter is only 21.6mm. Pluto is a small dot from your pencil!

You will need to decide how you wish to mark out your planets on this system. It is recommended to use two methods.

1. Firstly, choose objects or made up pictures or models of each planet glued onto a wooden stake. You can also use plastic sports cones from your sports shed. You do not need to use the table below. The sun and planets will **not** be to scale.
2. Use small balls, marbles, coloured sprinkles or pencil dots on paper to represent the more accurate size of planets, using the table below. However, you will notice that the Earth is 2mm in diameter and Pluto only 0.5mm. Using this table the planets are still **not** to scale. They are magnified by 10. To make an **accurate** scale model you will need to divide each diameter by 10. The earth would be 0.2mm and the sun 2.15mm. Pluto would be invisible.

Object	**Size diameter(mm)**	**Distance from the sun (m)**
The Sun	215 (21.5cm)	0
Mercury	0.8	1
Venus	1.9	1.8
Earth	2	2.5
Mars	1	3.9
Jupiter	21.6	13
Saturn	18	24
Uranus	7.3	48.5
Neptune	7	76
Pluto	0.5	100

Teacher information
Highlight that the solar system is a *system*, held together by gravity, and discuss the *relationship* between sun and planets in their orbits. On the GDC solar system walk, each step represents 4 million km in space. Students pace out a number of steps and work out how far they have travelled. How long would this take at the speed of light? Light travels at **300 000 km/s.** Introduce concept of light year as a measure of distance. A light year is **9.5 trillion km**. The light from the sun takes 8 minutes to travel to Earth. How far is this? Work it out using the speed of light (extension maths).

gravity DISCOVERY CENTRE

Lessons 6-8: Rockets

How to integrate rocketry in to your Science program

Teacher Background:
Rockets have been used for decades to explore the Solar System. From the first landings on the moon to current day missions to Mars, rockets are an integral part of our everyday lives. Rockets send satellites into earth orbits which provide humans with GPS systems, communication, satellite television and a range of other new and developing technologies. Rockets carry people and scientific equipment on a regular basis to the ISS, and may indeed become the source of transport for space tourism in the future.

Lesson:
Use the *Rockets Educator Guide* on the NASA website to choose a range of hands-on activities. First make paper rockets. Students *design, predict, test,* and *analyse* different types of rockets to investigate which design works best and why. Students use a drinking straw to shoot the rocket using a good lung full of air! Try using model planets as targets so that students can attempt to travel the furthest into the Solar System.

Try making rockets with no fins, one fin, two fins, three fins, or more. Use different weights in the top and tail of the rocket. Use different materials.

Resources:
http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Rockets.html

Suggested research questions:
How long does it take a rocket to reach Mars or the Moon?
How far away are these places?
How fast can rockets travel?
What might they be searching for on other planets (evidence of life or water?)?

Additional Teacher Resources

THE SOLAR SYSTEM WALK (at the GDC)

The solar walk demonstrates the vastness of the universe.
The Moon is our nearest neighbour at 385,000 km away.
The sun is 150 million km and the nearest star, Alpha Centauri, is 40 billion km away.

The distance between our planets of our solar system to a scale of 8 billion to 1 (8,000,000,000 : 1). The planets have been scaled at 40 thousand to 1 (40,000,000 : 1) otherwise many objects would be too small to see.

To reach Pluto you walk about 1.2 km.
When you walk every step you take represents about 4 million km.

Sun

The sun is our nearest star.
The Sun radiates light, planets reflect light.
The Sun is a big ball of gas held together by gravity. It is prevented from collapsing by the enormous pressure and temperature at its centre.

The gravity of the sun holds all the other planets in its grip.
The sun is a nuclear reactor. It creates energy by the fusion of hydrogen to create helium.
For billions of years the sun has produced the steady stream of energy upon which all life depends. It is gradually brightening (30% in the last 4 billion years)

Sunspots as big as the Earth increase in numbers over an 11 year cycle. The reason is unknown.
The Sun extends beyond the disk we see in the sky. The outermost part of the sun's atmosphere is called the corona.
The corona cannot be seen, except during a solar eclipse because the light from the sun overpowers it. It is a thin glowing gas reaching temperatures of 2 million C.

Mercury

Mercury is the closest planet to the sun.
A very small planet, Mercury is not much bigger than our moon.
It completes four orbits (4 Mercury years) in one earth year). It rotates very slowly. One Mercury day is nearly 2 Earth months.
The surface is pot marked like the moon.

Venus

Venus has the closest orbit to the Earth.
Venus is so bright it can be seen in the daytime. It is also known as the 'Evening Star'
Standing on Venus the sky would appear bright orange. It has a thick atmosphere of carbon dioxide heating up the planet by the 'greenhouse effect'. For this reasons it is the hottest planet in the solar system, hotter even than Mercury. Its clouds contain sulphuric acid. High in the atmosphere there are very strong winds (350 kph). However at the surface the wind speeds are only a few kilometres per hour.
Venus has a very slow orbit, 1 Venus day = 243 Earth days.

Earth
Planet Earth is unique in the solar system in that it is the only planet on which water can exist as a liquid. The Earth's moon rotates exactly once per orbit so that the Earth always sees the same face. The moon stabilises the spin axis of the earth. The moon is receding from the earth at around 3 cm a year.

The Moon of the Earth.

Mars
Mars appears bright red in the sky and is named after the Roman God of War.

The Martian day is about the same as an Earth day however Mars takes nearly twice as long to orbit the sun.

Mars is nearly half the size of the Earth and its surface temperature is below freezing. Standing on Mars you would feel much lighter because gravity on Mars is about one third that of Earth's gravity.

Mars has 2 tiny moons, Phobos and Deimos.

Asteroid Belt
Asteroids are large pieces of rock that are left over from the formation of the solar system. They did not merge into planets because Jupiter's gravity disrupted the process. Because of their small size, compared to planets, asteroids do not have enough gravity to pull themselves into balls.

Callisto moon of Jupiter

About 1.5 times as large as the Earth's moon and is a mixture of rock and ice

Io moon of Jupiter

Also called the pizza moon as it has active volcanoes spewing yellow / orange sulphur.

Jupiter
Jupiter rotates very quickly (10 earth hours) the extreme turbulence this causes creates its famous red spot which has a surface area larger than that of the Earth. Jupiter appears white in the sky but through a telescope it can be seen as a colourful disc.

Jupiter has 4 moons

Europa Moon of Jupiter is covered in an icy crust which could cover a deep ocean about 150 km.

Ganymede The largest of the moons in the solar system it orbits Jupiter and is larger than Mercury.

Titan Moon of Saturn. It is the second largest moon in the solar system. Titan is larger than Mercury and is unique in that it has a thick atmosphere of nitrogen and methane. The methane is like water on Earth, it forms clouds, rain and oceans.

Dione Moon of Saturn it consists of rock and ice.

Saturn
Saturn is a gas giant like Jupiter. It is a giant ball of gas held together by gravity. Saturn has an enormous system of rings. The rings consist of lumps of rock and ice. The ring system is very thin about 270,000 km across and only 100 m thick. Saturn's density is less than water.

Saturn has 4 moons

Rhea Moon of Saturn having similar composition to Dion consisting of rock and ice.

Iapetus Moon of Saturn consisting almost entirely of ice.

Titania Moon of Uranus consisting of frozen water and is very dark

Ariel Moon of Uranus consisting of frozen water and is very dark

Uranus
A telescope is needed to see Uranus from Earth and it appears as a blue-green disk.

Like Saturn, Uranus has rings; however they are too faint to be seen from Earth. They were first discovered by the Kuiper Airborne Observatory. (Highly modified C-141A jet transport aircraft). Uranus is known as the Topsy-Turvy planet as its axis is tilted so far it appears to rotate on its side.

Uranus has 5 moons

Miranda Moon of Uranus consisting of frozen water and is very dark. Miranda has a very strange crazy paving surface made of a patchwork of different features found nowhere else.

Umbriel Moon of Uranus consisting of frozen water and is very dark

Oberon Moon of Uranus consisting of frozen water and is very dark

Neptune

Neptune is similar to Uranus. However its atmosphere is bluer. Many storms rage across its surface. Neptune has a very faint ring system

Neptune has 2 moons

Triton Moon of Neptune, which can be seen from the Earth. It has icy volcanoes that spew out ice and liquefied gases.

Nereid Moon of Neptune

Pluto

There is some debate over whether Pluto really is a planet. It is so small and light that it and its moons could be considered a double asteroid.

Pluto has a very odd elliptical orbit that is at an angle to the plane containing the other planet's orbits.

Sometimes Pluto is closer to the sun than Neptune because of its elliptical orbit.

Charon Moon of Pluto is more than half the size of Pluto. Charon circles Pluto in exactly one Pluto day. Thus it always stays over the same spot on Pluto's surface. On Earth this orbit is called 'geosynchronous' orbit and is used for communication satellites.

Discussion and/or assessment questions:

(Following your excursion)

1. Make a model of the Solar System and use it to show the movement of the planets and moon.
2. Use your model of the solar system to describe how gravity keeps it together.
3. How do we know Sun is not moving across the sky during the day, but it looks like that because the Earth is rotating?
4. Why is the Sun important to us on Earth?
5. Why is it important to make careful measurements when doing science investigations, such as the one you did from the Learning Tower?
6. Use your experiments from the Leaning Tower to describe what gravity is.
7. What are some other questions that you could answer by doing experiments from the Leaning Tower?
8. What is an invention that has come from studying astronomy?