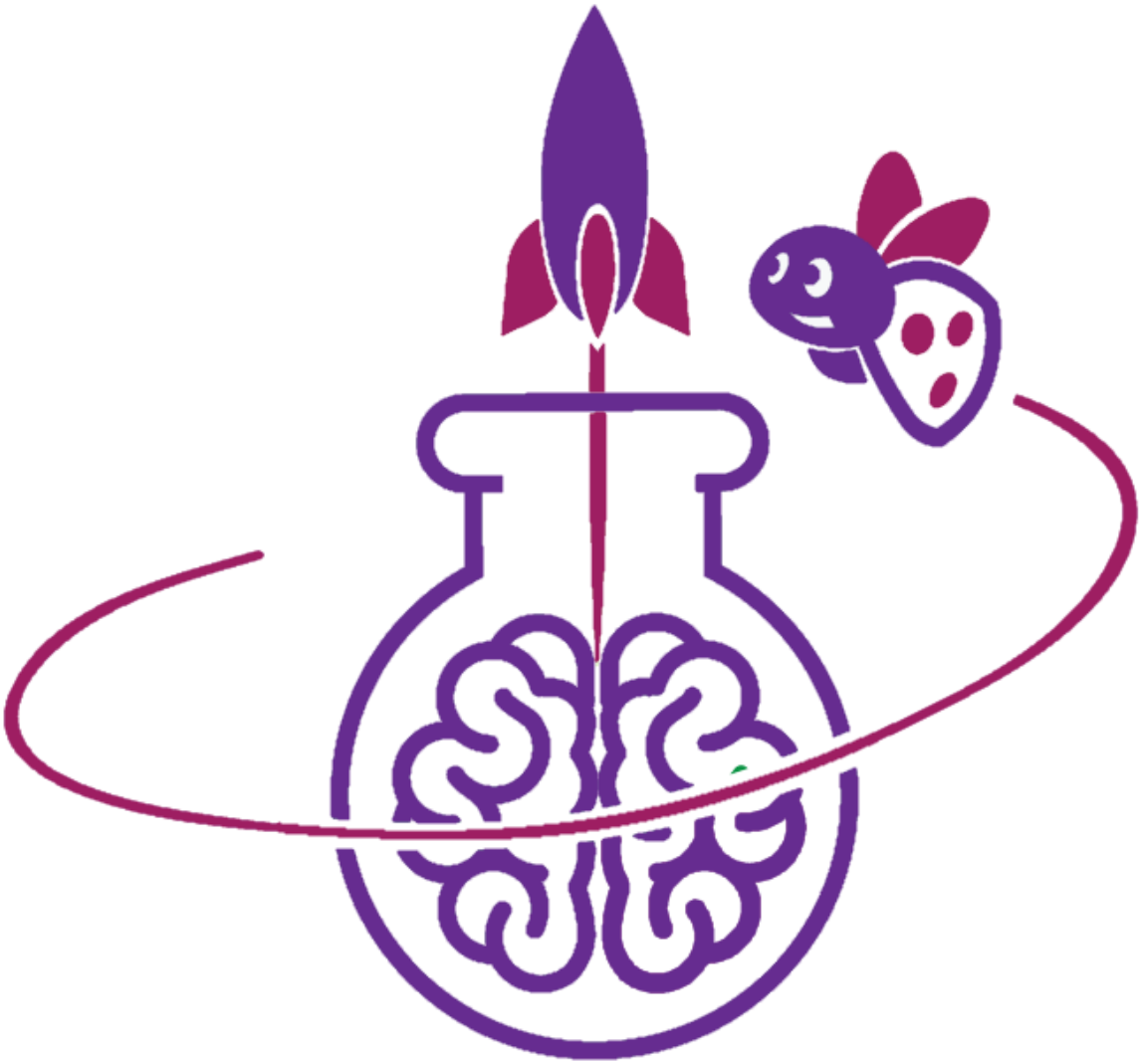

Empiribox

Nurturing Future Scientists

Forces, Magnetism & Space

Continuing Professional Development Logbook

Primary Science Teaching Continual Professional Training Session Descriptor and Record

Key Stage

Key Stage 2

Scheme of Work

Physics - Forces

Lessons 1 & 2: Introduction to Forces

Pupils Learning Outcomes

- ✓ Practise the skill of applying the terms "independent" and "dependent" variables.
- ✓ Practise the skill of making a prediction.
- ✓ Practise the skill of recording data in a simple way.
- ✓ Learn what force is and that force arrows are used to demonstrate direction.
- ✓ Understand that forces work in pairs.

Science Theory / Knowledge Covered

1. This training session covers an introduction to basic Newtonian mechanics focusing on Forces. The 3 laws of motion are covered and applied to a wide range of phenomena including gas and atmospheric pressure, space travel, moving objects etc.
2. An object at rest will remain at rest unless acted on by an unbalanced force. An object in motion continues in motion with the same speed and in the same direction unless acted upon by an unbalanced force. This law is often called "the law of inertia".
3. Acceleration is produced when a force acts on a mass. The greater the mass (of the object being accelerated) the greater the amount of force needed (to accelerate the object). This can be expressed mathematically as F=Ma (Force = Mass x acceleration).
4. When one body exerts a force on a second body, the second body simultaneously exerts a force equal in magnitude and opposite in direction on the first body.
5. Newton-meters are covered and the Newton scale of measuring the effect of gravity on mass. Using this to explain why you apparently weigh more if you suddenly crouch down on a mass balance 'weighing scale'.
6. Gas particles are constantly moving and if they are given more energy, they move faster and therefore collide with more force with any object they strike. Using this phenomenon to explain why footballs get soft if the air is cold and why the egg gets into and out of the flask.
7. An overview of the history of mechanics including the work of Archimedes, Galileo, Newton and Einstein.
8. In using the rubber Magdeburg spheres the 100 kPa of atmospheric pressure acts on the outside of the rubber spheres preventing, or at least making it very difficult, to separate.

Pupil Investigation and Scientific Skills Developed

1. Developing the skill of applying the terms independent and dependent variables.
2. Developing the skill of making a prediction.
3. Developing the skill controlling variables.
4. Developing the skill of recording data.
5. Develop the skill of handling a range of chemicals and equipment in order to perform the rocket popper experiment that involves quick manipulation of a film canister, accurate and precise use of a stopwatch and measuring cylinder.

Science Pedagogical Techniques Developed

Use of Science Demonstrations

Gravity Defying Water – This demo surprises pupils who think the weight of the water will make it fall to the floor. It also shows them that forces 'work' in pairs and that they may be invisible.

Egg in Flask - Engaging learners through the use of the classic egg into a flask in order to elicit from pupils their understanding of forces and deliberately correct misuse of 'sucking' as an explanation for the effect they see and better shape and refine their understanding of the concept of forces. Using this as a method of moving from the rather abstract concept of force to the concrete.

Magdeburg Spheres Engaging learners through the use of an unexpected demonstration to allow them, using all their understanding to try and explain what they see with small prompts from the teacher where necessary. This will also introduce pupils to the concept of force diagrams.

Lesson Delivery Techniques

Using a really fun experiment to effortlessly engage pupils in making accurate and precise measurements in order to develop their ability to plan and conduct a scientific experiment

Science Misconceptions Dealt With

1. Heavier objects fall faster than light objects. - Incorrect
2. Faster moving objects have a larger force acting on them. - Incorrect
3. Objects slow down if there is no net force. - Incorrect
4. There is no gravity in space. – Yes there is!
5. Light is not affected by gravity – Yes it is

Assessment for Learning Essential Elements and Suggested Activities

Assessment foci used in the lesson and how teacher will ensure students understand their level and how to progress.

Demonstrations - Providing explicit opportunities for AfL – getting at their ideas first before meeting the concept (true false sentences, annotated drawings, concept maps etc.) – providing the wherewithal so that children can say

'I used to think .... and now I think.... because ....' or *'I used to think .... and I still think .... because ....'*

Using pupils to create simple tests to give each other about the various parts required in planning an experiment. Creating a simple level ladder in the class the pupils can use to see how they might progress to a higher level.

Risk Assessment Procedures Developed with Reference to COSHH

Use of COSHH covered in relation to this lesson and demonstration. bit.ly/HSE-COSHH
Please refer to the Plants Risk Assessment

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Primary Science Teaching Continual Professional Training Session Descriptor and Record

Key Stage

Key Stage 2

Scheme of Work

Physics - Forces

Lessons 3 & 4: Friction

Pupils Learning Outcomes

1. Practice the skill of applying the terms “independent” and “dependent” variables.
2. Practice the skill of making a prediction.
3. Practice the skill of recording data in a simple way.
4. Develop the skill of constructing investigation apparatus.
5. Learn what friction is, what causes it, where it is useful and where it is not.
6. Learn to use a Newton Meter to measure a force.
7. Learn how to make scientific equipment that can be tested

Science Theory / Knowledge Covered

1. Understanding that friction opposes motion through both the physical contact between 2 surfaces and sometimes the chemical attraction between molecules of different substances.
2. How friction can be reduced and increased depending upon where it is not useful and where it is useful through use of lubrication, brakes or reduced drag in design. e.g aircraft, fast cars or Olympic sports equipment.
3. In the Vase and silk scarf demonstration, first show the pupils this clip: bit.ly/Top-Gear-Friction-Demo
   Tell them that you are faster than a sports car. There are two frictions at play here – the friction between the desk and the scarf, and the friction between the scarf and the vase. When at rest, the forces are balanced. Tugging gently on the scarf is enough to overcome the friction between the table and the scarf, so the vase moves. However, this force is not enough to overcome the friction between the cloth and the vase, as the vase stays in the same place on the cloth. A sudden acceleration (whipping motion) is however, enough the overcome this friction, and the cloth moves without moving the vase.
4. When making the balloon car, the idea is to reduce the friction between the wheels and the ‘road’ surface. The amount of friction is dependent on the amount of contact between the two, so pupils should choose the CD as theoretically the wheel with the lowest friction. Also, they need to beware of the amount the balloon is inflated as if over-inflated, it will touch the wheels, causing a braking effect (i.e. friction!). The smoother the road, the lower the friction. So theoretically, the cars will go further in the Hall than on the carpet in the classroom. (There are many other variables that can affect this experiment including: the shape of the car (air resistance), the mass of the car etc. Pupils need to be aware of these when planning their experiment.

Pupil Investigation and Scientific Skills Developed

1. Asking a question.
2. Determining Independent and Dependent Variables.
3. Making a Prediction / establishing a Hypothesis.
4. Writing a method that allows valid data to be gathered.
5. Controlling variables.
6. Identifying and mitigating risks.

Science Pedagogical Techniques Developed

Use of Science Demonstrations

The teacher will move a vase that has been placed upon a cloth to the edge of a table. They will then whip the cloth out from under the table without smashing or indeed moving the vase.

Lesson Delivery Techniques

Pupils will design and make their own cars from simple materials. The cars will be powered by balloons. They will then investigate the effects of friction on the cars by releasing them on different surfaces.

Science Misconceptions Dealt With

1. If forces are balanced, there is no friction.
2. The radius of the wheel is related to the amount of friction it has.
3. The mass of an object does not affect the friction.

Assessment for Learning Essential Elements and Suggested Activities

Assessment foci used in the lesson and how teacher will ensure students understand their level and how to progress.

Demonstrations - Providing explicit opportunities for AfL – getting at their ideas first before meeting the concept (true false sentences, annotated drawings, concept maps etc.) – providing the wherewithal so that children can say

'I used to think .... and now I think.... because ....' or *'I used to think .... and I still think .... because ....'*

Using pupils to create simple tests to give each other about the various parts required in planning an experiment. Creating a simple level ladder in the class the pupils can use to see how they might progress to a higher level.

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Primary Science Teaching Continual Professional Training Session Descriptor and Record

Key Stage

Key Stage 2

Scheme of Work

Physics: Magnetism and Simple Machines

Lessons 5 & 6:

Pupils Learning Outcomes

1. Practice making a prediction and develop the skill of testing variables.
2. Record scientific observations and begin to develop explanations.
3. Compare and group materials according to whether they are attracted to a magnet.
4. Learn that magnetism is a force that can vary in strength and work at a distance.
5. Learn that magnets have poles and the shape of a magnetic field.
6. Learn that pulleys and cogs are simple machines that makes work easier.

Science Theory / Knowledge Covered

1. Magnetism is a force generated by magnetic materials and electromagnets. This force has North and South poles, that the field can be described using field lines that are North seeking – with the North end of magnets coloured 'Red'. The field lines are what can be seen if a bar magnet is placed under paper and iron filings peppered over the magnet.
2. Only some types of materials are magnetic e.g. iron, cobalt, nickel and rare earth elements such as Neodymium.
3. The history of magnets and their use dates from the early Chinese navigators, and Greek mythology to the Earth's magnetic field and that rather interestingly the Earth's magnetic field tends to flip every 200,000 years or so!
4. Levers, screws and inclined planes are simple machines that simply act to reduce the amount of force required to perform work and be able to discuss a range of different simple machines in these categories from doors, screwdrivers, corkscrews.
5. Pulleys are simple machines that reduce the amount of work required to move an object. If you have a single wheel and a single rope, a pulley helps you reverse the direction of your lifting force. In your first demonstration you pull the rope down to lift the weight up. If you want to lift something that has a mass of 100g, you have to pull down with a force equivalent to 1N. If you want to raise the weight 1m into the air, you have to pull the rope a total distance of 1m at the other end. If you add more ropes and wheels, you reduce the effort you need to lift the weight. With 2 wheels and 2 ropes the 100g mass is now supported by two ropes instead of one (ignoring the loose end of the rope you're pulling with), so you can lift it by pulling with a force of just 0.5N—half as much, but twice as far! A pulley with two wheels and ropes gives a mechanical advantage (ME) of two.
6. Gears are simple machines that can be used to change the direction of a force, or to reduce or increase the force. Think about bicycle gears. They are also used to change the rotational speed. They can be combined to make very complex mechanisms to enable the precise control of movement – clockwork toys, clocks and watches, food mixer, drills, gear boxes in motors etc.

Pupil Investigation and Scientific Skills Developed

1. Pupils can make observations of scientific phenomena.
2. They can explain their observations using scientific theory they have learned.
3. They can plan an investigation identifying the independent and dependent variables.
4. They can make scientific equipment that can be tested.

Science Pedagogical Techniques Developed

Use of Science Demonstrations

Pupils will see the effects of using different types of lever using a door and screwdrivers. The teacher will also set up a pulley rig to show pupils that using pulleys allows a smaller force to be used to lift loads. They will also investigate gears and their uses.

Pupils will also see a Gauss gun and discuss how it works.

Lesson Delivery Techniques

Pupils will investigate a number of magnetic phenomenon arranged in a circus and make detailed observations. They will also make a compass using simple items.

Science Misconceptions Dealt With

1. Misconception: All levers are the same – No they are not, levers vary in the location of the fulcrum, load and effort.
2. Misconception: Longer screwdrivers make work easier – No they don't – it's the width of the handle that counts.
3. Misconception: All metallic-looking objects are magnetic. Fact: Not all metals are magnetic. Iron, steel, nickel and cobalt are metals which are magnetic.
4. Misconception: All objects made of iron and steel are magnets. Fact: Iron and steel are magnetic and can be made into magnets.
5. Misconception: Magnetism is a kind of gravity. Fact: Magnetic force and gravity are two different types of forces. Magnetic force is the force of attraction between magnets and magnetic materials or the unlike poles of two magnets, or the force of repulsion between two like poles of magnets. Gravity is the force of attraction between two masses.
6. Misconception: Magnetic force is called 'magnetic energy'. Fact: Force is a pull or a push; energy is the ability to do work.
7. Misconception: Poles of magnets are defined as the ends of magnets. Fact: Poles of magnets are the parts of the magnets where the attraction or repulsion is the strongest.
8. Misconception: Big magnets are stronger than small ones. Fact: Big magnets are not necessarily stronger than small magnets.

Assessment for Learning Essential Elements and Suggested Activities

Assessment foci used in the lesson and how teacher will ensure students understand their level and how to progress.

Demonstrations - Providing explicit opportunities for AfL – getting at their ideas first before meeting the concept (true false sentences, annotated drawings, concept maps etc.) – providing the wherewithal so that children can say

'I used to think .... and now I think.... because ....' or *'I used to think .... and I still think .... because ....'*

Using pupils to create simple tests to give each other about the various parts required in planning an experiment. Creating a simple level ladder in the class the pupils can use to see how they might progress to a higher level.

Risk Assessment Procedures Developed with Reference to COSHH

Use of COSHH covered in relation to this lesson and demonstration. bit.ly/HSE-COSHH
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Primary Science Teaching Continual Professional Training Session Descriptor and Record

Key Stage

Key Stage 2

Scheme of Work

Physics: Forces

Lessons 7 & 8: Air and Water Resistance

Pupils Learning Outcomes

1. Practice making a prediction and testing variables.
2. Make systematic and careful observations.
3. Record scientific observations and develop explanations.
4. Identify the effects of air resistance and water resistance.

Science Theory / Knowledge Covered

1. This lesson covers the use of particle theory to explain how air resistance is caused and how Newton's laws of motion can be applied to the operation of a parachute.
2. Air resistance, also called drag, is the forces that are in opposition to the relative motion of an object through the air. Drag forces act opposite to the oncoming flow velocity. Drag, unlike other resistive forces, depends directly on velocity.
3. Air resistance is air pushing against a moving object. The air pushes on the object as the air gets out of the way to let the object through. If you've ever been on a rollercoaster, or cycled fast downhill, you might have felt this air resistance as a wind on your face.
4. Bikes, cars and other vehicles experience air resistance as they move. Air resistance is caused by the frictional forces of the air against the vehicle. The faster the vehicle moves, the bigger the air resistance becomes. The top speed of a vehicle is reached when the force from the cyclist or engine is balanced by air resistance.
5. Air resistance is a force that slow down objects that are moving through the air.
5. This is because the air is made of particles, like any other material and these rub on the surface of a falling object, the resulting friction slowing down the rate of acceleration due to the downward pull of gravitational force
6. The greater the surface area of the object, the greater air resistance. Obviously the more surface there is, the greater the number of particles that the falling object is likely to collide with resulting in increased friction.
6. The faster an object is falling through air, the greater the air resistance. The faster that the object is falling increases not only the frequency of impact but the force of impact which results in greater friction forces acting between the object and the air.
7. When objects falling to the ground are no longer accelerating but travelling at a constant velocity, the forces of air resistance and gravitational force are said to be balanced.

Pupil Investigation and Scientific Skills Developed

1. Asking a question.
2. Determining Independent and Dependent Variables.
3. Making a Prediction / establishing a Hypothesis.

Science Pedagogical Techniques Developed

Use of Science Demonstrations

Pupils will see a surprising demonstration of how bubbles can remain suspended in the air using vinegar and bicarbonate of soda. This is also an opportunity to discuss the chemistry of this reaction.

Pupils will also see the effects of surface area on air resistance using differently sized home-made parachutes.

Lesson Delivery Techniques

Pupils will investigation the effects of water resistance on plasticine shapes. They also have the opportunity to link the amount of resistance can be linked to density of particles by changing the liquid.

Science Misconceptions Dealt With

1. Misconception: Big/heavy things sink, small/light things float. Fact: It makes no difference.
2. Misconception: Flat things float. Fact: It only depends on density differences.
3. Misconception: Things with holes sink. Fact: No ...clearly not.
4. Misconception: "air is inside or on top of a parachute, but not around it". Fact: air is clearly all around the parachute.

Assessment for Learning Essential Elements and Suggested Activities

Assessment foci used in the lesson and how teacher will ensure students understand their level and how to progress.

Demonstrations - Providing explicit opportunities for AfL – getting at their ideas first before meeting the concept (true false sentences, annotated drawings, concept maps etc.) – providing the wherewithal so that children can say

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Primary Science Teaching Continual Professional Training Session Descriptor and Record

Key Stage

Key Stage 2

Scheme of Work

Physics: Forces

Lessons 9 & 10: Rocket Science

Pupils Learning Outcomes

1. Practice the skill of making a prediction and testing variables.
2. Record scientific observations and develop explanations.

Science Theory / Knowledge Covered

1. Gravity is a force exerted by every object on every other object and there is a direct linear relationship between mass and gravity, i.e. if mass doubles, gravity doubles. It is the force of gravity that causes mass to accelerate towards the centre of the Earth and that this causes objects to have weight.
2. Hero's engine demonstrates Newton's third law of motion which very simply states: 'for every action there must be an equal and opposite reaction'. The gas molecules in the engine collide rapidly with every part of the interior of the container except where the little vents are. When the gas exits the holes there is nothing to oppose it, so it leaves pushing against nothing. However, the gas particles elsewhere collide with container causing it to move in that direction as a consequence.
3. The crush can demonstration is quite a difficult bit of science for pupils to comprehend. The steam created in the can forces most of the air out, leaving mostly steam inside the can. When the can is cooled on the outside the steam condenses leaving a partial vacuum inside the can and therefore little pressure. However atmospheric pressure presses down and sideways on it. This force causes the can to 'implode'. Imagine a column of air 1 cm by 1cm rising from the ground and reaching up into space. This air has mass and the gravity of the Earth pulls on this to give it weight. This column of air weighs about 10 N. There are similar columns everywhere and so the bigger the area we choose, the bigger the weight of the air. This is air pressure and is about 10 N/cm2 or 100,000 N/m2 (that's 10 tonnes/m2!)

Pupil Investigation and Scientific Skills Developed

1. Asking a question.
2. Determining Independent and Dependent Variables.
3. Making a Prediction / establishing a Hypothesis.
4. Controlling variables to obtain valid results.
5. Mitigating risks.

Science Pedagogical Techniques Developed

Use of Science Demonstrations

Pupils will see Newton's third law of motion in action with the Hero's engine.

The power of air pressure is shown in the crushed can experiment.

Lesson Delivery Techniques

Pupils will make foam rockets and test them by firing them and recording the distance travelled.

Science Misconceptions Dealt With

1. The exhaust from the rocket pushes against the ground to take off. Not true!
2. A rocket moves in space because the gases are given momentum as they are expelled by the rocket engine. Consider the rocket resting in space. There is no momentum in the system. Next, the engine ignites. As the exhaust gases go in one direction, the rocket goes in the other to keep the total momentum of the system constant. This momentum change of the gases gives the rocket the "push" to go forward. We call this push, the thrust of the rocket, i.e. the force exerted on the rocket by the burning gases.
3. Air pressure is not very strong because we cannot feel it.
4. Air does not weigh anything – Incorrect – 1 cubic meter of air (allowing for temp and pressure and humidity) is approx. 1.3Kg.

Assessment for Learning Essential Elements and Suggested Activities

Assessment foci used in the lesson and how teacher will ensure students understand their level and how to progress.

Demonstrations - Providing explicit opportunities for AfL – getting at their ideas first before meeting the concept (true false sentences, annotated drawings, concept maps etc.) – providing the wherewithal so that children can say

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Primary Science Continual Professional Development – Earth and Space

Key Stage

Key Stage 2

Scheme of Work

Physics: Forces

Lessons 11 & 12: Earth and Space

Pupils Learning Outcomes

1. Practice the skill of making a prediction.
2. Develop the skill testing variables.
3. Record scientific observations and develop explanations.
4. Describe the movement of the Earth, and other planets, relative to the Sun in the solar system.
5. Learn that the Earth and other planets are approximately spherical objects – not perfectly round that rotate about their axis.
6. Learn that night and day occur because the Earth rotates once every 24 hours.
7. Explain that unsupported objects fall towards the Earth because of the force of gravity acting between the Earth and the falling object.
8. Describe the movement of the Moon relative to the Earth.
9. Learn that planet Earth is one of 8 planets in the Solar system with the Sun at its centre.

Science Theory / Knowledge Covered

1. The solar system consists of the Sun, the planets, the moons and all the other minor objects that orbit the Sun, such as comets and asteroids. Although the basic picture of planets orbiting the Sun is known to all school children, prior to the seventeenth century the widely held view was that Earth was at the centre of the universe, and that the stars and planets all revolved around Earth. This view was based on the model of the Greek philosopher Ptolemy, who lived from about 127-151 AD.
2. We have the Inner Solar System which has Mercury, Venus, Earth and not forgetting Mars. These are closest to the sun and are called the terrestrial planets simply because they have very solid rocky surfaces.
3. The Outer Solar System has Jupiter, Saturn, Uranus, Neptune these are sometimes called the gas giants. Out past Neptune you'll find the small planet of Pluto which has a solid but icier surface. Many don't class this as a planet anymore. The two systems are separated by the asteroid belt.
4. Our Solar System also contains comets, moons, dust, gas and some minor planets.
5. Our solar system is elliptical in shape. That means it is shaped like an egg. The Sun is in the centre of the solar system, and everything is always in motion.
6. The Sun is the biggest object in our solar system. It contains more than 99% of the solar system's mass.
7. Astronomers think the solar system is more than 4 billion years old.
8. Astronomers are now finding new objects far, far from the Sun which they call dwarf planets. Pluto, which was once called a planet, is now called a dwarf planet.
9. NASA launched an unmanned space probe in 1977, called Voyager 1. Its job was to fly away from Earth, through the solar system, visiting planets on the way, sending back pictures and information for NASA scientists to study.
10. Voyager has sent back pictures of Jupiter and Saturn, and is still travelling away from earth. It is now the farthest travelled space craft ever launched.
11. Voyager 1 is fast - it covers around 17 kilometres every second. Despite its incredible speed, it did not pass the last planet of the solar system until 1990. By early 2009, Voyager 1 was over ten billion miles away from the sun!

Pupil Investigation and Scientific Skills Developed

1. Pupils will realise the importance of research before investigations can take place.
2. Pupils will be able to design and build models that reflect real observations.

Science Pedagogical Techniques Developed

Use of Science Demonstrations

Pupils will investigate the solar system.

Lesson Delivery Techniques

Pupils will investigate the solar system and make their own models of the planets etc.

Science Misconceptions Dealt With

1. The solar system is very crowded.
2. The solar system contains only the sun, planets and the moon.
3. Meteors are falling stars.
4. Comets and meteors are out in space and do not reach the ground.
5. The surface of the sun is without visible features.
6. The galaxy is very crowded.
7. Stars are evenly distributed throughout the universe.
8. All stars are the same size.
9. It is not self-evident that the Earth is a planet orbiting the sun. We notice the sun's apparent movement across the sky each day and talk about the sun rising, coming up, going down, setting going behind clouds, all of which imply that it is the Sun rather than the Earth that is moving.
10. There is no gravity on the moon.
11. All the stars in a constellation are near each other.
12. All the stars are the same distance from the earth.

Assessment for Learning Essential Elements and Suggested Activities

Assessment foci used in the lesson and how teacher will ensure students understand their level and how to progress.

Demonstrations - Providing explicit opportunities for AfL – getting at their ideas first before meeting the concept (true false sentences, annotated drawings, concept maps etc.) – providing the wherewithal so that children can say

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