Activity A: Biodiversity

In this activity you will work as a Biologist to measure the biodiversity of different ecosystems to find out how healthy they are. You will find where different species live and how many there are. You can then work out ways to protect the environment.

Aim: To investigate the biodiversity of different areas of Fairfield High School grounds.

Technical vocabulary:

Ecosystem: A community of living organisms in conjunction with the nonliving components of their environment, air, water, soil, etc, interacting as a system.

Biomass: The total quantity or weight of organisms in a given area.

Biodiversity: The variety of organisms present in different ecosystems.

Abundance: How common a particular species is in an ecosystem.

Distribution: The geographical area where a species can be found.

Population: The total number of a species that live in an ecosystem.

Location: Science lab and school grounds

Equipment: trundle wheels, rulers, measuring tapes, electronic scales, scissors, markers, Elefun game

Session 1 - Biomass Calculation

The amount of plants in an area depends on the amount of sunlight, water and nutrients there. If you want to assess how healthy an ecosystem is you need to measure the total biomass of plants in that area.

Aim: To determine the biomass of a grassed area in the school grounds

Method:

1. Measure the length and width of a grassed area.
2. Calculate the area.
3. Remove 1cm^2 of grass.
4. Measure the mass of the grass.
5. Calculate the total mass of grass in the area.

Results:

Length = __________ m   Length = _________ cm

Width = ___________m   Width = _________ cm

Area = ___________m^2 Area = _________ cm^2

Mass of $1cm^2$ of grass = ___________ g

Total mass of grass = ___________ g

Total mass of grass = ___________ kg

Calculations:

1 m = 100 cm   1kg = 1000g

Area = length x width

Total mass of grass = mass of $1cm^2$ x area (cm^2)

Conclusion:
The biomass of grass in the area was _______________________________________ kg.

Fill in the names of the Australian ecosystems
Rank the Australian ecosystems from the greatest biomass to the least biomass.

________________ ________________ _______________ _________________

Session 2 – Transects

Transects are used to find out where different organisms live in an ecosystem. If you want to measure biodiversity you need to take transects of different areas and compare the results.

Aim: To compare the biodiversity of vegetation in two different areas of the school grounds.

Method:

1. Stretch out a 10m measuring tape in a straight line.
2. Draw a corresponding 10cm line.
3. Record the position of any plant in contact with the tape.
4. Include a key to identify the types of plants.

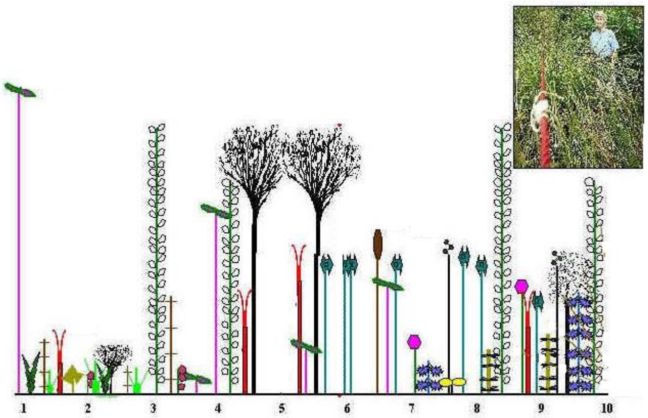
Results:

Location of Transect1:

____

Location of Transect 2:

____



Transect 1:

Scale 1:100

Key:

Transect 2:

Scale 1:100

Key:

How many different types of plants were in transect 1?

____

How many different types of plants were in transect 2?

____

Which area had the greater biodiversity? How do you know?

____

____

____

Why is biodiversity important?

____

____

____

____

Session 3 - Capture Mark Recapture

In an ecosystem each living thing depends on all the other organisms living there. If the population of one species suddenly decreases all the other species will be affected. This is why it is important to know the abundance of each species that lives in the area. It is impossible to count them all individually, but there are sampling methods that can be used, such as the capture, mark, recapture technique that can estimate the population.

Aim: To model sampling methods used to determine the abundance of a species of butterfly.

Method:

1. Fold some crepe paper butterflies. Count the total number of butterflies and place the butterflies in the machine.
2. Turn on the machine and use the nets to capture the butterflies.
3. Count the total number of captured butterflies.
4. Mark each of the captured butterflies and return all butterflies to the machine.
5. Turn on the machine and use the nets to again capture the butterflies.
6. Count the total number of captured butterflies and the number of marked recaptured butterflies.
7. Use these values to estimate the total number of butterflies.
8. Compare the estimate to the actual number of butterflies.

Results:

Number of butterflies placed in the machine at the start	
Number of butterflies captured and marked in the first sample	
Total number of butterflies captured in second sample (including marked and unmarked)	
Number of marked butterflies captured in the second sample	
Estimate of the total number of butterflies (from the calculation)	

Calculation:

$$\text{Estimate of the total number of butterflies} = \frac{\text{Number of butterflies captured and marked in the first sample}}{\text{Number of marked butterflies captured in the second sample}} \times \text{Total number of butterflies captured in second sample (marked and unmarked)}$$

Compare the actual number of butterflies you placed in the machine to the estimate.

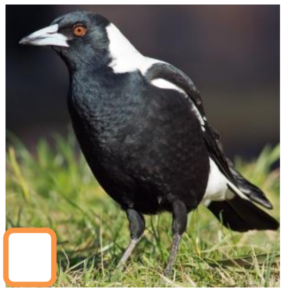
Actual number of butterflies = _______________

Estimated number of butterflies = _______________

The estimated number was **greater than / less than / equal to** the actual number

Write the name of the Australian species

Chose the species that could have their population estimated using the capture, mark recapture method.



The capture-mark-recapture technique is best used for which types of living things?

Why is it important to know the abundance of different species?

Activity B: Making Electricity

In this activity you will work as a Power Engineer to produce electricity. Electricity is used in almost all aspects of life, but the different devices you use need different voltages to work properly and safely. For example, you laptop needs 19 Volts, but the fridge needs 240 Volts. There are many different ways to produce electricity, including burning coal and gas, wind power, solar power and different types of batteries.

Aim: To investigate different ways of making electricity.

Technical Vocabulary:

Electrochemistry: Electricity produced by a chemical reaction

Voltage: A measure of electrical energy

Current: The flow of electricity

Battery: A device that coverts chemical energy into electrical energy

Light Intensity: A measure of light energy

Solar Cell: A device that converts light energy into electrical energy

Location: Science Lab

Equipment: STELR kits, microscope lamps, light intensity meters, metre rulers, tape, zinc and copper electrodes, sand paper, zinc sulfate (1M) solution, copper sulfate (1M) solution, filter paper, 250ml beakers, leads, voltmeters, a variety of fruit, chopping boards, knife (teacher use)

Session 1 – Electrochemistry – Galvanic Cell

Electricity is a form of energy that occurs in nature, such as in lightning strikes. Certain chemical reactions also produce electricity. All batteries contain chemicals that react together to make electricity by changing chemical energy into electrical energy.

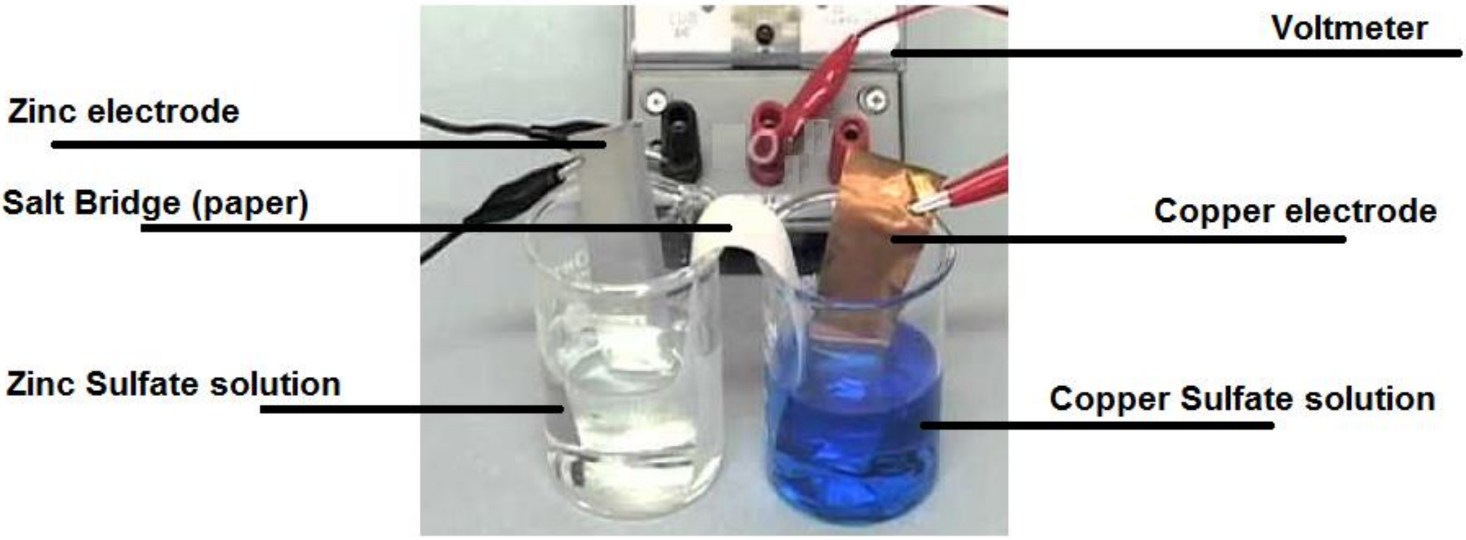
Aim: To produce electricity from a chemical reaction.

Safety:
Review lab safety procedures
Students wear lab coat and eye protection
Students wash hands when activity is complete

Method:

1. Set up the galvanic cell as shown in the diagram.
2. Measure the voltage produced by the galvanic cell.

Diagram:



Results:

Voltage = _______V

Conclusion:

The voltage produced by the chemical reaction _________________________________ Volts

How to read a voltmeter

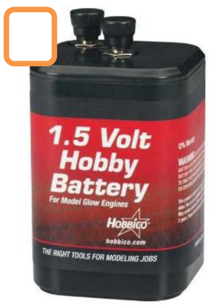
There are two scales:
0 – 20V and 0 – 2V

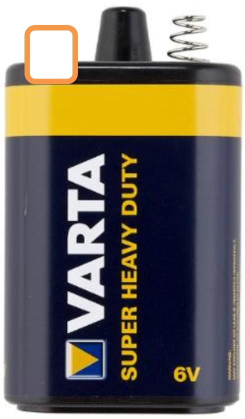
Use 0 – 20V for high voltages
Use 0 – 2V for low voltages

For 0 – 20V, each division (line) is 0.5V
For 0 – 2V, each division (line) is 0.05V

What voltage is produced by each of the batteries?

Rank the batteries from lowest to highest voltage.





__________ __________ __________ __________ __________

Session 2 – Electrochemistry - Fruit Batteries

For a battery to work it needs two different metals and a way for the electricity to travel from one metal to the other. The sugars in some fruit juices can conduct electricity.

Aim: To determine which fruit makes the best fruit battery.

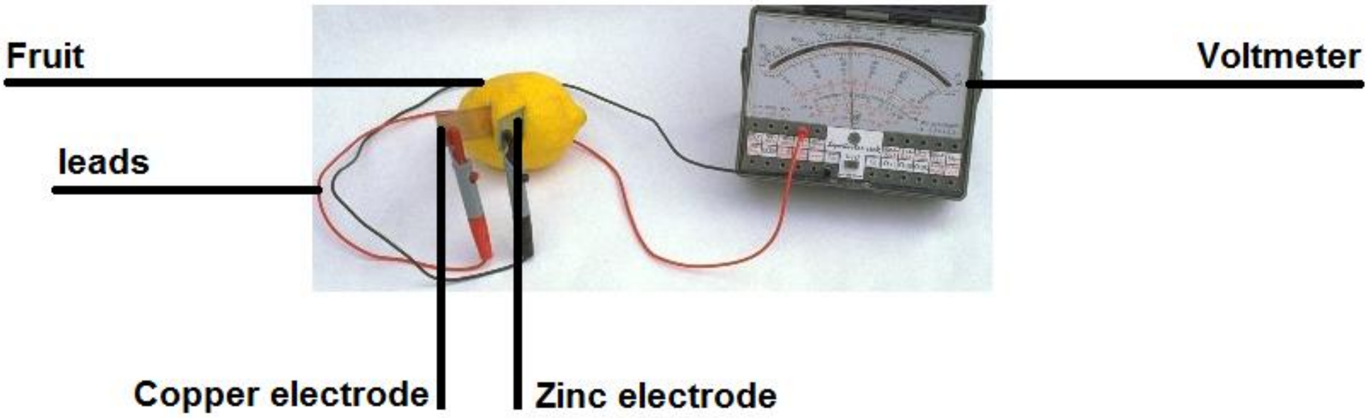
Prediction: ___________ will produce the most electricity because ________________

____

Method:

1. Teacher prepares fruit by cutting two slits for the electrodes.
2. Students set up a fruit battery and measure the voltage produced.
3. Repeat for other types of fruit.
4. Record results in the table.
5. Use tabulated data to determine whether the prediction was correct.

Diagram:



Results:

Name of Fruit	Voltage (Volts)

The prediction was **correct / incorrect**. I know this because ____________________

____

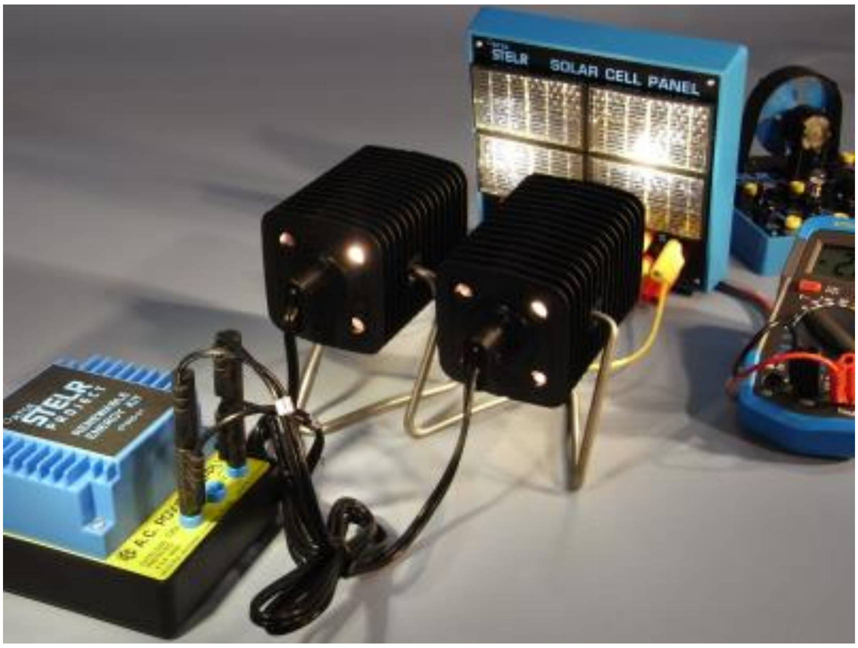
Session 3 - Solar Energy

Solar cells change light energy into electrical energy. They are a renewable way of making electricity because the sunlight does not get used up. The problem with using solar cells to make electricity is that they do not work in the night time or on cloudy days.

Aim: To investigate the effect of light intensity on the output of a solar cell.

Method:

1. Set up the panel of solar cells.
2. Tape the metre ruler to the desk to measure the distance between the light source and the solar cells.
3. Hold the lamps as close as possible to the solar cells and measure the voltage produced.
4. Move the lamps 1cm from the solar cells and measure the voltage produced.
5. Measure the voltage at set distances from the solar cells.



Results:

As the lamp was moved away from the solar cells, the amount of light energy reaching the panels **increased / decreased**.

As the lamp was moved away from the solar cells, the amount of electricity produced by the panels **increased / decreased**.

Distance (cm)	Voltage (V)
0	
1	
2	
3	
4	
5	
10	
15	
20	
30	
40	
50	

Plot a graph of Voltage against distance on the grid.

Give the graph a title. ________________________________

How does this result relate to the real world?

____

____

____

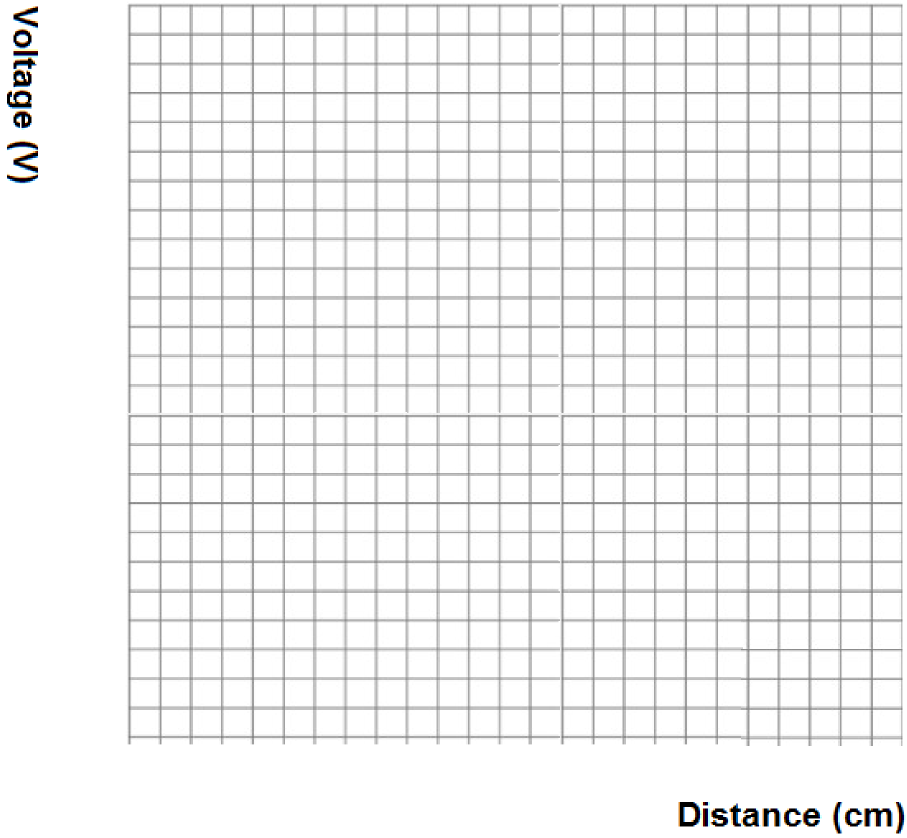
____

____

____

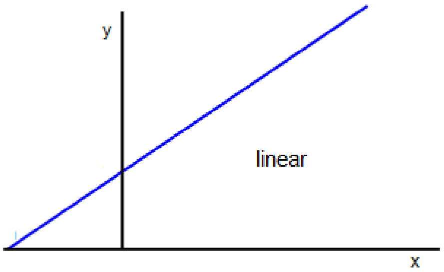
____

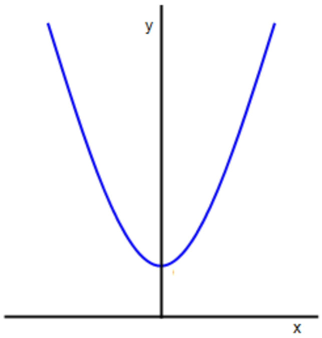
____

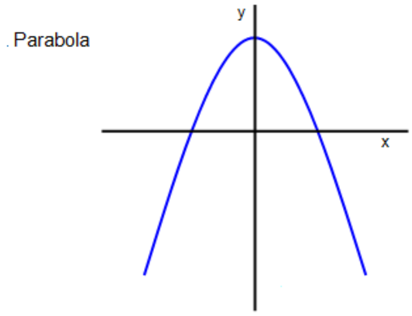


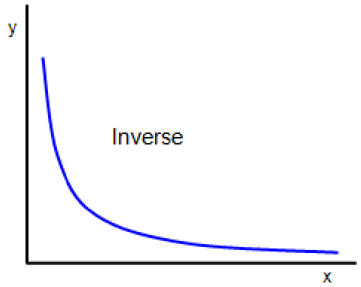
Compare the shape of your graph with those below. Which type of graph most closely matches your graph? ______________

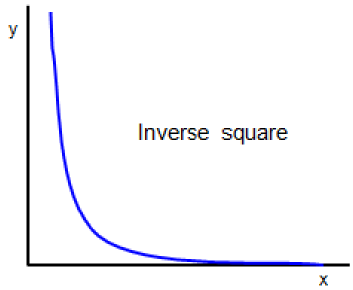
Types of Graphs

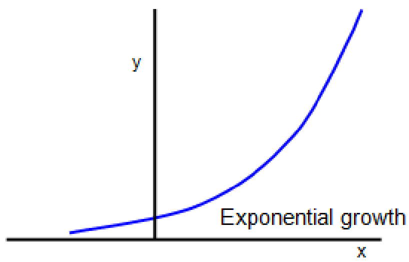


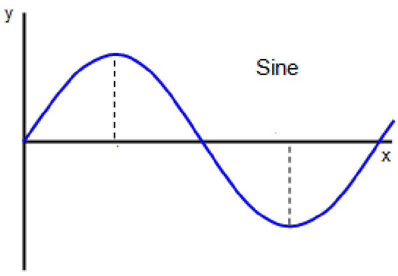


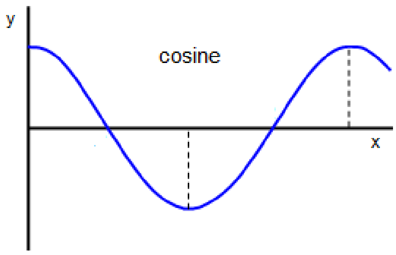


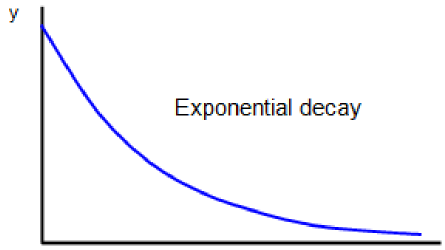












Activity C: Lung Capacity and Fitness

In this activity you will work as a Sports Scientist to measure your performance in one aspect of physical fitness. You will also measure your lung capacity and collect evidence to decide if there is any relationship between how much air your lungs can hold and your physical performance.

Aim: To investigate the relationship between lung capacity and physical fitness.

Technical Vocabulary:

Lung capacity: the maximum volume of air that can be inhaled in one breath

Physical fitness: the ability to carry out tasks with fatigue (tiredness)

Flexibility: the ability of the body's joints to move freely

Endurance: the ability to maintain a set activity level for a long period of time

Agility: the ability to quickly change the body's position or direction

Balance: the ability to stay upright or in control of the body's movements

Coordination: the ability to smoothly control the movement of two or more body parts

Power: the ability to exert a force in the shortest time, accelerating, jumping, throwing

Speed: the ability to move quickly

Location: Classroom and school grounds

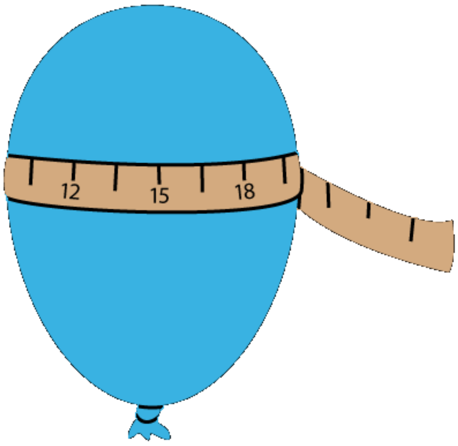
Equipment: round balloons, paper measuring tapes, stopwatches, long measuring tapes, ipads (CMV video recording app)

Session 1 – Measuring Lung Capacity

Your body needs oxygen to stay alive. The cells in your body use this oxygen to make energy. When you breathe in, the air travels through your trachea and into your lungs. The oxygen in the air then passes into the blood and is carried around your body. Your brain, liver, intestines, heart and muscles all need oxygen.

Aim: To determine lung capacity.
Method:

1. Take a deep breath in.
2. Use one breath to fill a balloon as much as possible.
3. Measure the circumference of the balloon with the measuring tape.
4. Wait a few minutes and repeat to obtain three readings.
5. Calculate the average balloon circumference.
6. Calculate the average balloon volume, the volume of air in one breath.



Measure circumference at the widest part of the balloon

Results:

	Balloon Circumference (cm)
1	
2	
3	

Average balloon circumference = __________ cm

Average balloon circumference = __________ m

Radius of the balloon = __________ m

Volume of the balloon = __________ m^3

Volume of air in one breath = __________ m^3

Calculation:
Average value = $\frac{\text{(sum of all the values)}}{\text{(number of values)}}$

1metre = 100 centimetres

Calculation:

Radius of a circle = $\frac{\text{circumference}}{2 \times \pi}$

Volume of the balloon = $4/3 \times \pi \times (\text{radius})^3$

Conclusion:

My lung capacity was ____ cubic metres.

This calculation is for a sphere. The balloon is not an exact sphere. The volume of air in one breath is therefore an approximation. This is one of the errors in this method. Errors like this are called systematic errors because they are the same for every reading.

What is another error in this method? ___________________________________

Was this a systematic error? **yes / no**

Is it worthwhile to do experiments even though they have errors? Why/Why not?

____

____

____

____

____

Session 2 – Physical Fitness

There are many aspects of physical fitness, such as, strength, flexibility, endurance, agility, balance, coordination, power and speed. Different sports need different forms of fitness, for example, long distance runners and sprinters are both fit, but in different ways.

Work in a group to choose one aspect of physical fitness that can be used to test the physical fitness of the members of your group.

- **Choose an activity that is safe, with a very low risk of injury**
- **Choose an activity that all members of the group can participate in**
- **Choose an activity that will give quantitative data (numbers)**
- **Discuss your plan with the teacher**

Design an experiment to test the physical fitness of the members of your group.

Title:

Aim:

Equipment:

Safety:

Hazard	Consequences	Probability	Prevention

Method:

Diagram:

Results Table:

Discussion:

Which aspect of physical fitness was tested?

strength / flexibility / endurance / agility / balance / coordination / power / speed

Rank the people tested from the most fit to the least fit based on your results.

____

____

Do you think the results would be different if a different aspect of physical fitness was tested? Why? / Why not?

____

____

____

____

What could be done to make this experiment more reliable?

____

____

____

____

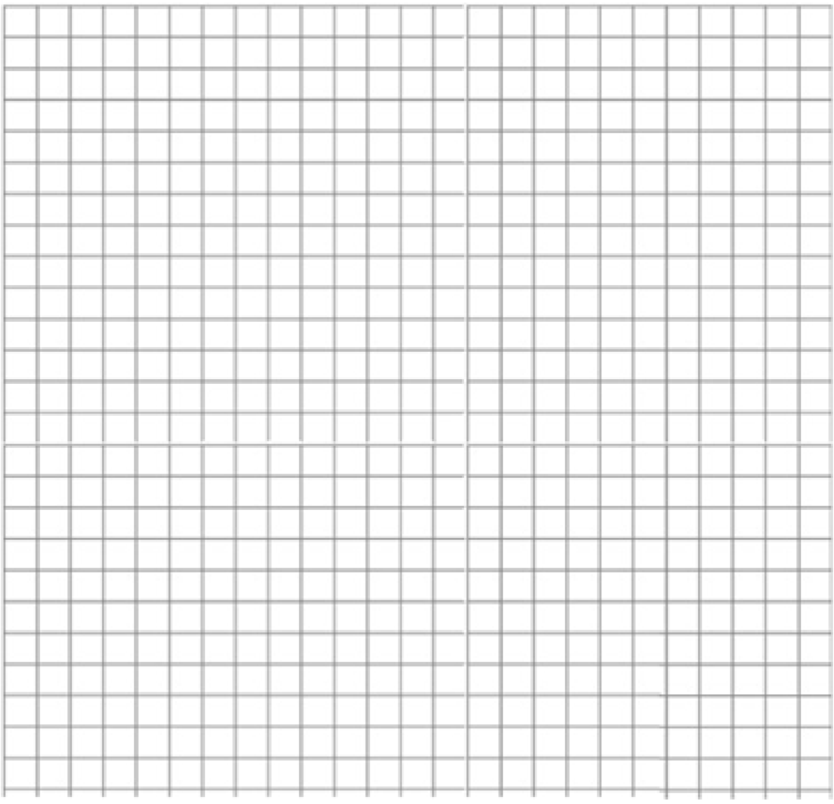
Conclusion: ____

Session 3 – Correlation

When you are exercising your body needs more energy. To make this energy the cells in your body need more oxygen. This is why you breathe faster when you are exercising compared to when you are relaxing.

Aim: To determine whether lung capacity correlates to physical fitness.

Plot the physical fitness of each member of you group against their lung capacity.



Lung Capacity (m^3)

From the graph, is there any relationship between lung capacity and that aspect of physical fitness? **yes / no** How do you know?

Do you think this experiment is a good test of the relationship between lung capacity and physical fitness? Why?/Why not?

How could this experiment be improved?

Activity D – Propulsion

In this activity you will work as an Aeronautical Engineer to design, test and modify a glider. You will analyse the forces on objects and work out what factors affect how a glider flies to produce an optimised design that can be communicated to others.

Aim: To investigate the factors that affect the movement of objects through the air.

Technical Vocabulary:

Projectile: Any object that when dropped or thrown only experiences the force of gravity (no motor or engine)

Gravity: the force experienced by all masses in the universe

Acceleration: the rate at which an object's speed changes

Acceleration due to gravity: the rate at which a projectile's speed changes as a result of gravity (approximately 10 m/s^2 on Earth)

Location: Classroom and school grounds

Equipment: 4 different types of balls, 30m measuring tape, stopwatch, straws, paper, scissors, sticky tape, paper clips

Session 1 – Projectiles - Balls

Different balls are designed for different sports. They are different sizes, shapes, weights and made of different materials. Some balls need to bounce, others are for throwing, kicking or hitting. Engineers use equations to solve problems and test designs so that each ball performs to the required standard for that sport.

Aim: To determine the maximum height different balls can be thrown.

Prediction: __________ will be the highest because _________________________

____

Method:

1. Choose one type of ball.
2. Throw the ball into the air as high as possible.
3. Catch the ball.
4. Record the time the ball was in the air.
5. Calculate the time for the ball to reach maximum height.
6. Calculate the maximum height of the ball.
7. Repeat for the other types of balls.

Results:

Ball	Total time the ball is in the air(s)	Time to maximum height (s)	Acceleration due to gravity (m/s^2)	Maximum Height (m)
			10	
			10	
			10	
			10	

Calculation:

$$\text{Time to maximum height} = \frac{\text{Time the ball is in the air}}{2}$$

Maximum Height = ½ x (acceleration due to gravity) x (time to maximum height)^2

Discussion:

Which ball did you throw the highest? _______________

Why do you think you threw this ball higher than the others?

____

____

____

Rank the balls you threw in order from highest to lowest.

____

____

What could be done to improve this experiment?

____

____

____

____

How does this experiment relate to real life?

____

____

____

____

____

Session 2 – Projectiles – Loop Gliders

A glider is a type of projectile. It does not have a power source, such as a rocket, jet engine or propeller. Once a projectile is launched it only experiences the forces of gravity and air resistance. Gravity pulls the glider back down to Earth and air resistance stops the glider moving forward through the air.

Aim: To investigate the factors that affect the performance of a loop glider.

Method:

1. Cut two strips of paper.
2. Tape the paper to form a large loop and a smaller loop.
3. Tape the loops to the straw to make a loop glider.
4. Use the measuring tape to test the distance the loop glider can travel through the air.

Modify your loop glider to answer each of the questions.
Use data to justify your answers.

Questions:

i. Does the position of the loops on the straw affect the distance it flies?

____

____

____

ii. Does the length of straw affect the flight?

____

____

____

iii. Do more loops help the loop glider to fly better?

____

____

____

Is it a projectile? **Y / N**

Session 3 – Projectiles – Loop Gliders Optimisation

If you want to make something the best it can be you need to optimise it. If you change everything at once you will not know which change had the most effect. You need to be systematic and change only one thing at a time. You also need to do lots of tests to make sure that you really have the optimum design. Once you are satisfied that you have the best design you need to make careful measurements so that you can accurately communicate your design.

Aim: To optimise the performance of a loop glider.

Method:

1. Cut strips of paper.
2. Tape the paper to form loops.
3. Tape the loops to the straw to make a loop glider.
4. Use the measuring tape to test the distance the loop glider can fly.
5. Change one aspect of the design, remake and retest glider.
6. Continue to modify the design and retest the plane.

Some Possible Modifications:

- Change the size of the loops
- Change the number of loops
- Change the position of the loops
- Change the length of the straw
- Change the number of straws
- Change the weight of the glider (using paperclips)

Results:

Maximum Distance = __________m

The maximum distance was ______________________________________ metres

Draw a detailed diagram of your final design. Include measurements so that someone could use the drawing to make an exact copy of your final design.

Activity E – Number Patterns in Nature

In this activity you will be working as a Biomathematician to find patterns in living things. These patterns mean that organisms that seem very different from each other, actually have many things in common. All living things are made of cells. They use energy and respond and adapt to their environment. They grow, develop and reproduce.

Aim: To investigate the occurrence of Fibonacci sequences in nature.

Technical vocabulary:

Fibonacci sequence: is the series of numbers: 0, 1, 1, 2, 3, 5, 8, 13, 21, 34, ... where the next number is found by adding the two numbers before it.

Golden Ratio: is a special number approximately equal to 1.618. Represented by the symbol Φ. It appears many times in nature, geometry, art, architecture, etc.

Fossil: Preserved remains of ancient organisms

Ammonite: An extinct marine animal with a spiral shell

Location:
Classroom and school grounds

Equipment: pencil, calculator, ammonite fossil, protractor, ruler, scissors, PVA glue, origami paper

Session 1: Fibonacci calculations

The Fibonacci sequence is one of the most common number patterns in nature. You can work out the Fibonacci sequence by starting with 0 and 1. You find the next number by adding the two numbers before it. From the Fibonacci pattern you can calculate the Golden Ratio. You divide one Fibonacci number by the number that comes before it.

Aim: To calculate numbers in the Fibonacci sequence

Method:
1. Start with the numbers, 0 and 1. Add the numbers to calculate the next value.
2. Continue to add the last two numbers to form the Fibonacci sequence.
3. Record these values in the table.
4. Divide the last two numbers in the series to calculate the Golden Ratio.
5. Record these values in the table 2.
6. Use the Golden Ratio to construct a spiral on the grid paper.

Results:

Table 1: Fibonacci Sequence

0	zero
1	one
1	one

Table 2: Golden Ratio

1/1	1
2/1	2
3/2	1.5

Calculation:

The Fibonacci sequence is the series of numbers:

0, 1, 1, 2, 3, 5, 8, 13, ...

The next number is found by adding up the two numbers before it.

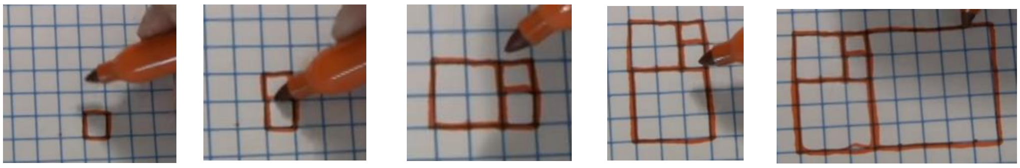
Eg. 2 + 3 = 5

The Golden Ratio, ϕ, can be approximated by dividing a number in the Fibonacci series by the number that comes before it in the series.

Eg. 5/3 = 1.6667

Circle the Fibonacci Numbers.

Draw a spiral using the Fibonacci sequence.



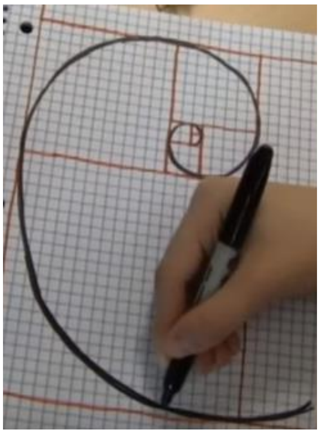
Instructions:

Draw a 1 x 1 square in the centre of the grid.

Draw a 1 x 1 square beside it.

Continue to draw squares that match the total size of the other squares.

Draw a curve through each square that arcs from one corner to the opposite corner to make a spiral.



How does the spiral relate to the Fibonacci sequence?

____

____

____

Draw an accurate picture of a fossilised ammonite shell.

How does the shape of the ammonite shell relate to the Fibonacci sequence?

In nature, a fern grows in a spiral shape. Draw and name examples of other living things that naturally have a spiral shape.

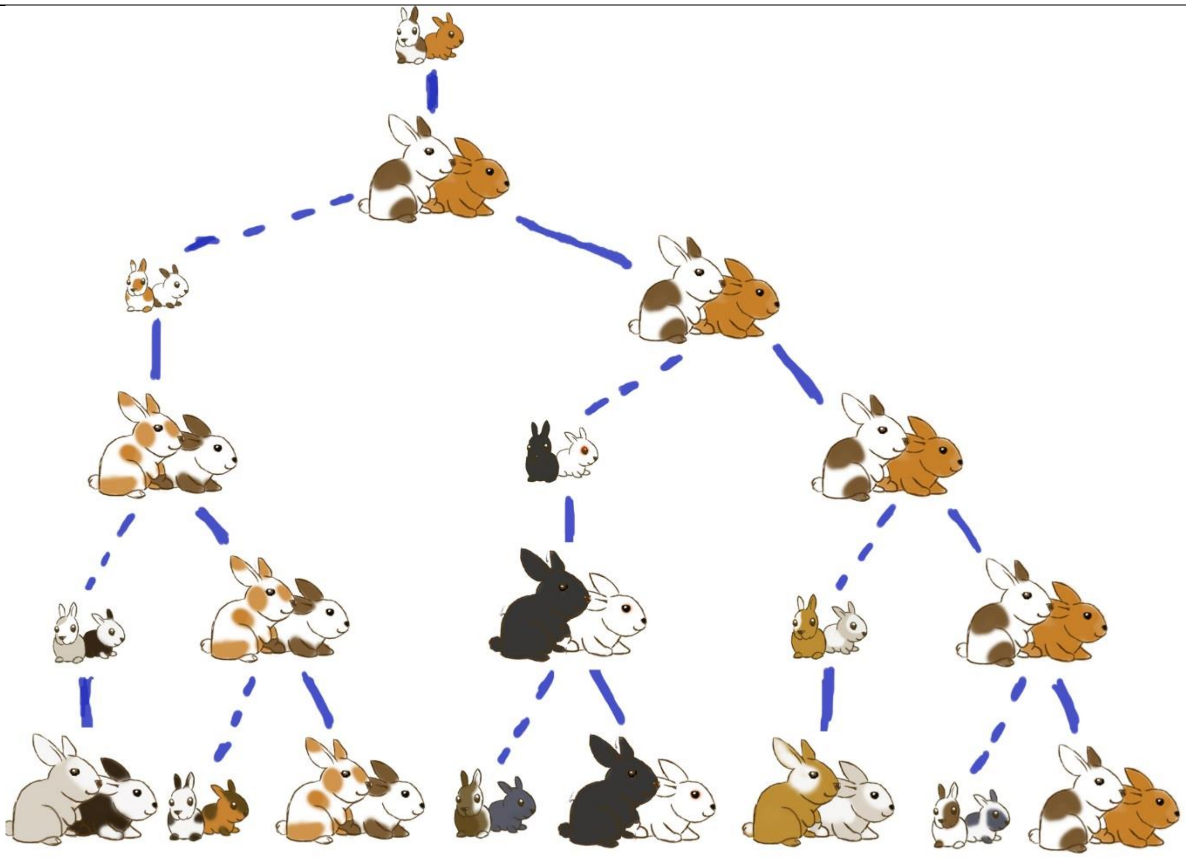
Session 2 – Fibonacci number patterns in nature

Fibonacci worked out his number series by thinking about what would happen if two baby rabbits were placed in a field. He knew the rabbits would grow up and have their own babies. His goal was to work out how many rabbits would be in the field at the end of the year if no rabbits died.

Aim: To model the population of rabbits.

Method:
1. A pair of baby rabbits is placed in a field.
2. In one month the rabbits grow up and mate.
3. In two months the rabbits produce a pair of baby rabbits.
4. In three months the original pair have produced another pair of baby rabbits and the first pair have mated.
5. Calculate how many rabbits are in the field at the end of the year if no rabbits die.

Results:
Draw the rabbits and calculate the total number of rabbit pairs for the next month

Month	**Model of Rabbit Population**	Pairs of Rabbits
January		1
February		1
March		2
April		3
May		5
June		8
July		

How many months are in one year? ____________

How many rabbits (not pairs) were in the field in May? ___________

How many rabbits were babies in June? ________

Use the Fibonacci sequence to determine how many pairs of rabbits will be in the field by the end of the year?

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In the real world there would be less rabbits in the field than the model predicts. Explain why.

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Why do scientists use models, like the Fibonacci sequence, if they are not 100% accurate?

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Session 3 – Fibonacci Patterns in Plants

Plants have different structures to do different jobs. The flowers of a plant are for reproduction. The roots absorb water from the soil. The stem carries water from the roots up to the leaves. The leaves use sunlight, water and gases from the air to make energy for the plant to grow and develop. When new leaves grow they need to be exposed to the maximum level of sunlight, but not block the sun from reaching the leaves below them. The leaves of a plant will grow in a particular pattern to do this.

Aim: To investigate the structure of plants.

Method:
1. Observe the structure of a plant.
2. Draw a diagram of the plant and label the stem, roots and leaves.
3. Count the number of leaves on the plant. Record this number.
4. Measure the angle between the leaves on the stem.

Results:

Labelled Plant Diagram

Number of leaves = _____________ Is this a Fibonacci number? **yes / no**

Angle between the leaves = ___________

How many degrees are in a circle? ___________

What value is, ϕ, the Golden Ratio? ___________

Divide the degrees in a circle by ϕ.

____

____

Is the angle between the leaves close to this value? **yes / no**

Explain why plants do not grow with their leaves positioned on top of each other.

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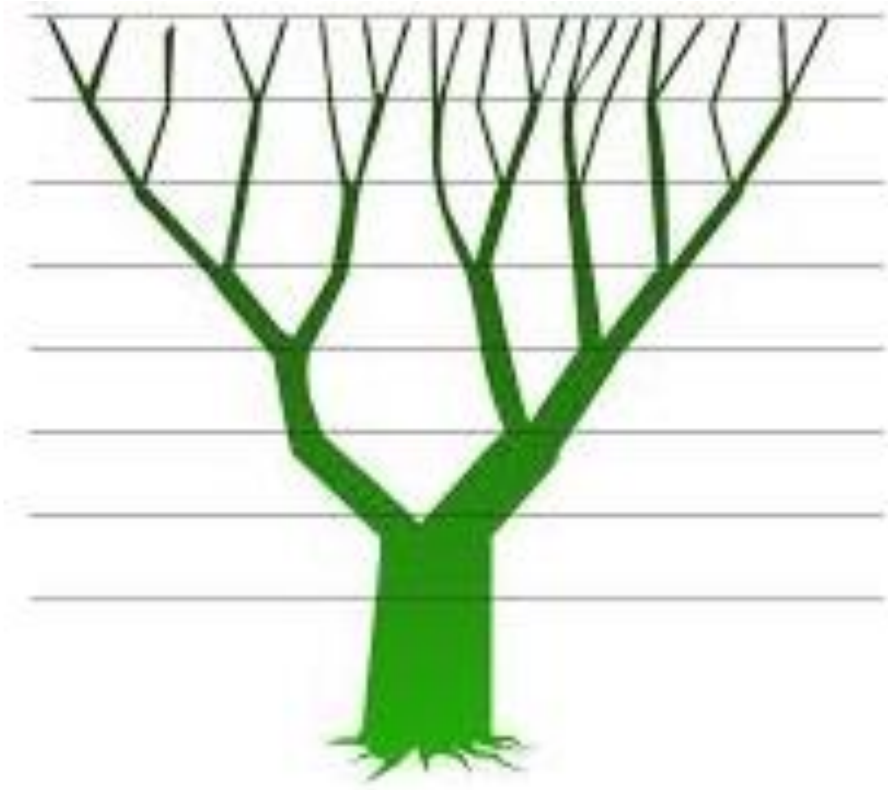
Discussion:

A Fibonacci sequence can be found in the growth of trees and the petals of flowers.



Count the number of branches at each growth stage. Write the number on the line.

Is this a Fibonacci series? **yes / no**

Explain why trees grow branches like this rather than having only two branches.

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Count the number of petals on each flower and determine if it is a Fibonacci number.

	Number of Petals	Fibonacci Number (Y/N)
		
		
		
		
		
		
		

Follow the patterns to create paper flowers with five petals or eight petals.

<u>Five Petal Flower Pattern</u>

1.Take a square of origami paper

2. Fold the square in half.

3. Use a ruler and pencil to measure and mark a point one third of the distance from the top left corner.

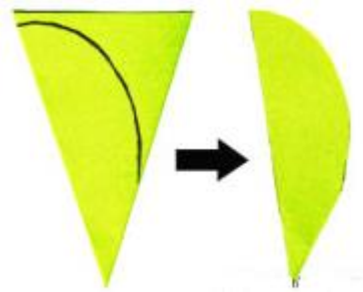
4. Fold the bottom right corner to the marked point.

5. Fold the bottom left corner over the right edge.

6. Fold the top right corner over the left edge.

7. Cut along the top horizontal edge to make a triangle.

8. Draw half-a-petal starting from the top left corner of the triangle to about 1cm from the bottom of the opposite side. Cut along the line.



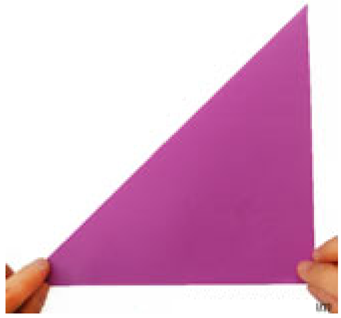
9. Unfold the paper to reveal a five petal flower. Cut a circle from a different colour paper and glue it to the centre of the flower.

Five Petal Flower Model

Eight petal flower pattern

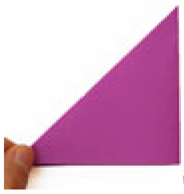
1. Take a square of origami paper.

2. Fold the square diagonally in half to form a triangle.



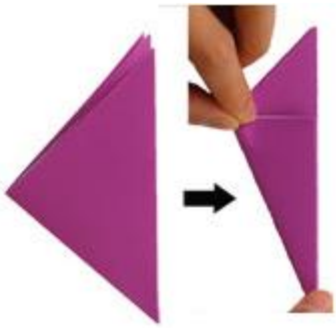
3. Fold the triangle in half to form a smaller triangle.

4. Fold the triangle in half to form an even smaller triangle.



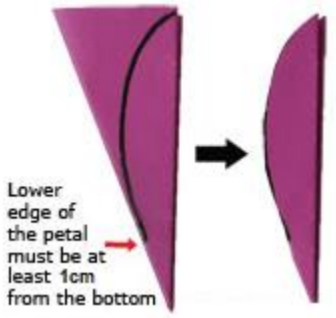
5. Rotate the triangle so that its longest side is positioned vertically and its solid corner (the corner corresponding to the paper's centre) is at the bottom.

   Bring the short side closest to the bottom towards the triangle's long side.



6. Cut along the top horizontal edge to make a triangle.

7. Draw half-a-petal starting from the top corner of the triangle's vertical side and ending about 1cm from the bottom of the triangle's long side. Cut along the outline.



8. Unfold the paper to reveal an eight petal flower. Cut a circle from a different colour paper and glue it to the centre of the flower.

Eight Petal Flower Model

Glue two 8-petal flowers together to make sunflowers or daisies.

Create a set of leaves by cutting green paper into a slightly larger 8-petal flower. Glue this under layers of 8-petaled flowers.