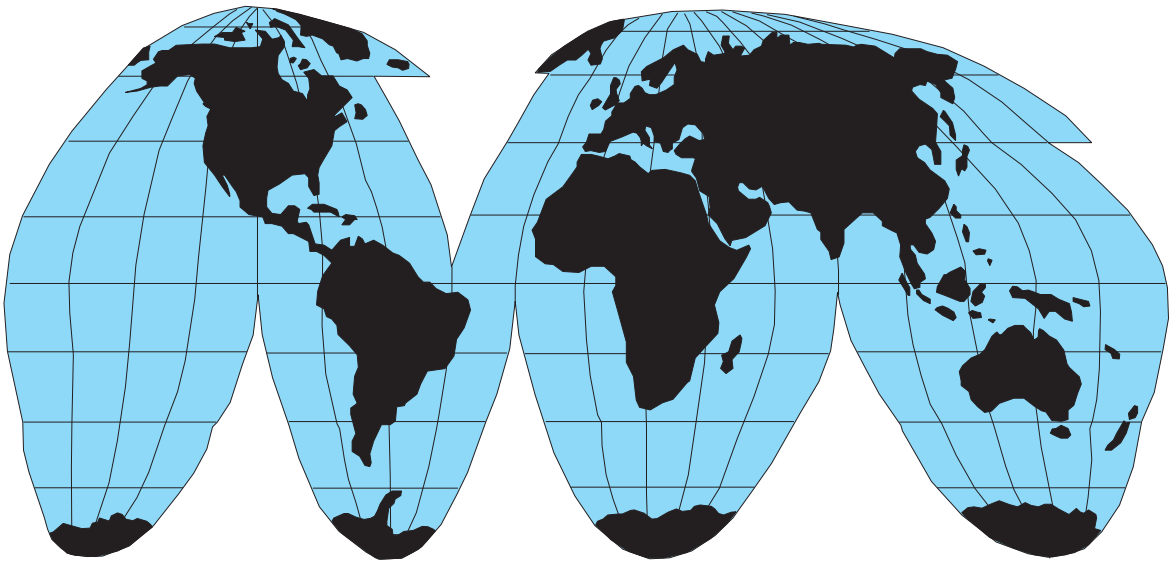
COUNTRIES OF THE WORLD

1. Choose four countries and state their name and on which continent they would be found.
2. State the population of each country and list the countries from the smallest to the largest population.
3. State the area of each country and list the countries from smallest to largest area.
4. Draw the flag for each country.
5. Draw a map of each country clearly showing the location and name of its capital city.
6. Find statistics for each country that include:
(a) decimal numbers (e.g. 1.2 million people live in the capital city).
(b) fractions (e.g. 2/3 of the population are Muslims).
(c) percentages (e.g. 20% of the exports is wool).
7. Choose one of the countries and draw a graph (column, pie, etc.) that describes one aspect of that country (e.g. religion, trade, education, food, land use, etc).
8. Unscramble these words to find the names of ten countries of the World.

PAJAN RAIN PLANE DINIA PETGY ANGRYME
DANGLEN CREAMIA PURE ZABLIR

9. Scramble the letters of the countries you chose.
10. State the sources of the information you found for this project.

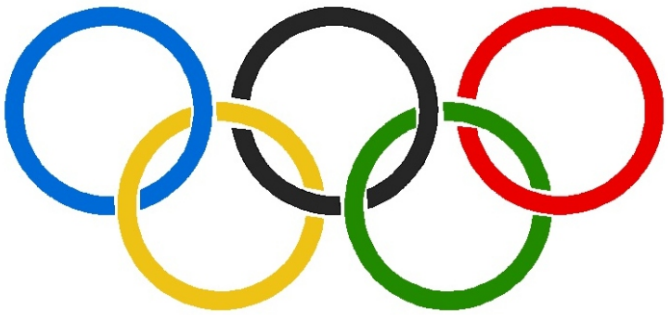


SPORT

1. Choose a sport.
2. For this sport find:
(a) when and where the sport started to be played.
(b) in which countries it is popular.
(c) its popularity - how many people participate in the sport.
Draw a graph (column, pie, etc.) to compare the popularity of the sport with other popular sports.
3. Draw a diagram showing the field, court, board, etc. on which the sport is played. Clearly show all dimensions on the diagram.
4. Find the size and weight of the major equipment used in playing the sport (e.g. balls, bats, racquets, etc.)
5. Find statistics involved with the sport that include:
(a) decimals (e.g. the ball used weighs 3.5 kg)
(b) fractions (e.g. the game is played in four quarters).
(c) percentages (e.g. 10% of the population play this sport).
6. Describe the time involved with playing the sport.
7. Describe the scoring involved with the sport.
8. Conduct a survey on at least 20 people to a question involved with sport. You decide on the question (e.g. What is your favourite sport?)
Display the information in a table and a graph (column, pie, etc.)
9. Unscramble these words to find the names of ten sports.

SINNET MADBINNOT GROWIN STRAD TICKREC
TALLBEN CHOKEY GINWIMMS FIGSURN HASSQU

10. Scramble the letters of the sport you chose.
11. What do the five colours of the Olympic rings stand for?
12. State the sources of the information you found for this project.

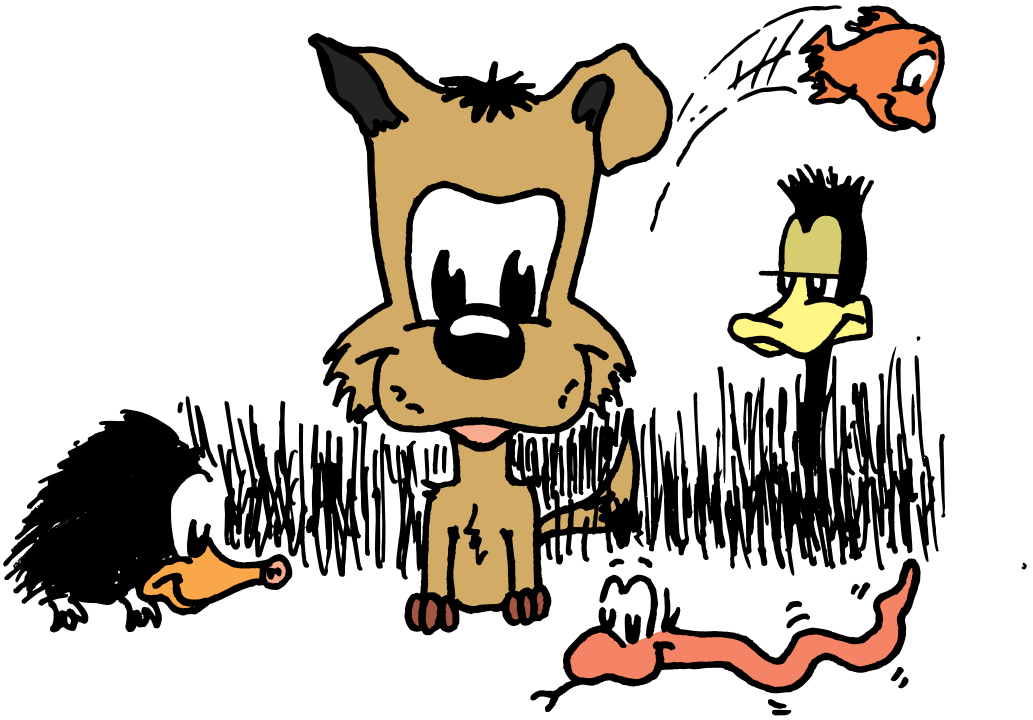


ANIMALS

1. Choose four animals.
2. (a) For each animal find its average weight when fully grown.
(b) List the animals from the lightest to the heaviest.
(c) For each animal find its average weight when born.
(d) For each animal find its average height when fully grown.
(e) Find the record for the largest of each animal ever recorded.
(f) Find the normal travelling speed of each animal.
3. (a) State which countries each animal is naturally found.
(b) Find statistics on the population of each animal.
(c) Represent this information on graphs (column, pie, etc.).
4. Find statistics involved with each animal that include:
(a) decimals (e.g. the animal weighs 3.5 kg)
(b) fractions (e.g. one third of the animals live in Australia).
(c) percentages (e.g. the animal loses 40% of its body weight during hibernation).
5. Describe the diet of each animal.
6. Unscramble these words to find the names of ten animals.

OLIN BARKROAKOU BATMOW KINKS GORF BARE
KRASH THEPLANE LOW TUTOR

7. Scramble the letters of the animals you chose.
8. State the sources of the information you found for this project.

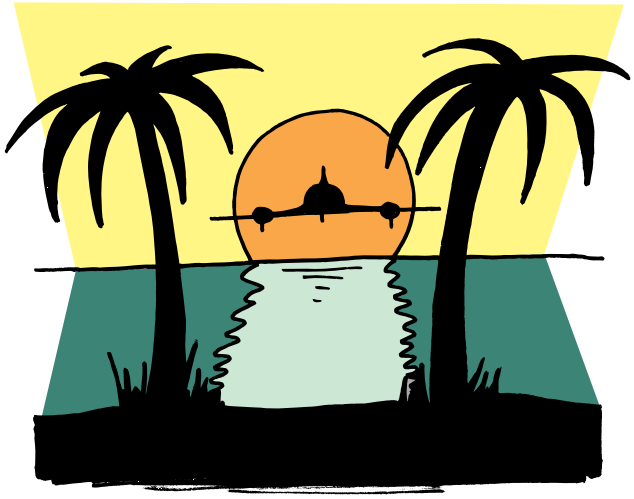


TRAVEL

1. Choose two countries that are popular overseas travel locations, with at least one that does not have English as its national language.
2. (a) For each location state the currency (unit of money).
(b) State the conversion rate between the currency in each country and the Australian dollar. Give examples.
3. For each country find the name of the capital city.
4. For each country find the name of the international airport (or one of the international airports if there are more than one).
5. For each country find the name of the national airline.
6. For each location find the time zone and use a table to compare the time in these locations to that in Australia.
7. Find statistics involved with each location that include:
(a) decimals (e.g. the Australian dollar is approximately 0.6 Euros)
(b) fractions (e.g. one third of the country's economy is based on tourism).
(c) percentages (e.g. 40% of the population speak English).
8. For each location find the language usually spoken by the local people. Find a few words of each language and their translation.
9. What are the main tourist attractions at each location?
10. Use a graph to compare the temperature variations over a year for the two locations and the nearest capital city to where you live.
11. Unscramble these words to find the names of ten tourist locations.

BAIL JIFI AVUNUTA YITAL WEN-DANAZEL
TYPEG FANCER REALDIN AWAIHI HANIC

12. Scramble the letters of the locations you chose.
13. State the sources of the information you found for this project.



MATHEMATICIANS

Many areas in mathematics are named after the mathematicians that were involved with discovering them. Some examples of these are given below:

Euclidian Geometry	***Fibonacci Numbers***
Pascal's Triangle	***Hero's (Heron's) Formula***
Pythagoras' Theorem	***Venn Diagrams***
Euler's Formula	***Mobius Strip***
Cartesian Geometry	***Newton's Method***
Celsius Degrees	***Napier's Bones***

Choose one of the above, or choose your own, and write a report on the mathematician and the area of mathematics named after them. Include in your report their date of birth and death, nationality and some of their other achievements.

SCIENCE AND MATHEMATICIANS

Many famous scientists were also involved with developments in mathematics. Some examples of these are given below:

Isaac Newton	***Albert Einstein***	***Johannes Kepler***
Archimedes	***Karl Gauss***	***Galileo Galilei***
James Maxwell	***Ptolemy***	***Nicholas Copernicus***

Choose one of these, or choose your own, and write a brief report on the scientist/mathematician (include date of birth and death, and nationality) and some of their contributions to mathematics and science.

THE CALENDAR

Write a report on the history of our calendar. Your report should include the following:

- How long is Earth's year exactly?
- Why are there leap years and how often do they occur?
- The Roman Calendar, Julian Calendar and Gregorian Calendar
- The origin of the seven day week.
- The origin of the names for the days and months.

NUMBER SYSTEMS

The number system we use is called the decimal system with a base of 10.

1. Write a report on the history of our number system.

There were many other number systems.

For example:

The Babylonians used a ***sexagesimal*** number system.

The Romans used, for some purposes, a ***duodecimal*** system.

The Mayans used a ***vigesimal*** system.

2. Find the base number for these three systems

3. Investigate one of these or another number system.

BASE NUMBERS

The decimal number system has a base number of 10.

The digits 0-9 are used in the decimal system and distinguish a number with base 10 a subscript of 10 is used; eg. 456_{10}

The binary system (as detailed earlier in this book) has a base of 2. The binary system is used by many computer systems. The digits 0 and 1 are used in the binary system.

Example of binary number are: 1011_2, 11010011_2

A number system with 5 as a base would be called a quinary system.

1. State the digits that would be used in numbers with this base.

2. Describe how a number could be converted from base 10 to base 5.

3. Convert the following numbers to base 5:

(a) 6_{10} (b) 25_{10} (c) 84_{10} (d) 129_{10} (e) 194_{10} (f) 7441_{10}

4. Convert the following numbers to base 10:

(a) 32_5 (b) 431_5 (c) 1324_5 (d) 22443_5 (e) 4321234_5

UNITS

1. The metric system which is based on metres, seconds and kilograms is also called the SI system. What does SI stand for?
2. What is the history behind each of these basic units of measurement - metre, second and kilogram?
3. The system of measurement used in Australia before the metric system was based on feet, seconds and pounds. What was this system of measurement called?
4. Several other units of measurement in this system are listed below. Convert these measurements to metric units:
(a) 1 furlong (b) 1 chain (c) 1 stone (d) 1 pennyweight

STATISTICS

The following information can be found on the Australian Bureau of Statistics website: www.abs.gov.au.

1. Find Australia's current population.
2. Find the average time between births in Australia.
3. Choose two states of Australia and find the state population and the population of the capital city in that state.
4. Find the number of people employed and unemployed. These figures can be found in the Labour Force section.
5. Find (or calculate) the percentage of people that are employed.
6. Find information about the percentage of the population that follow each of the different religions.
7. Find the current world population.
8. Find and copy the graph showing the world population growth rate. Comment on the change in growth rate of the world's population.
9. In the section on World Population by Age and Sex, choose a year and find the total male and female population in the world.
10. Are there more males or females in that year?
11. Find the difference between the number of males and females.
12. In that year choose two age groups - one of young people and the other of very old people. Comment on the comparison between the number of males and females in these two age groups.
13. Calculate the percentage of each sex in each of these age groups.

EUCLIDEAN DIVISION ALGORITHM

The Euclidean division algorithm can be used to find the greatest common divisor (highest common factor) of two natural numbers.
There are two examples below of the Euclidean division algorithm.

1. Research the Euclidean division algorithm to discover how it works and using the examples below describe the steps involved.

Examples

1. Find the greatest common divisor of 1071 and 1029.

***Answer* = 21**

1071	1029
1029	42
42	21
21	0

2. Find the greatest common divisor of 351 and 104.

***Answer* = 13**

351	104
104	39
39	26
26	13
13	0

2. Use this method to find the greatest common divisor of the following pairs of numbers.
(a) 117 and 81 (b) 200 and 72 (c) 465 and 75 (d) 1863 and 1035

3. A farmer owns two properties. One is 490 hectares and the other is 1092 hectares. He wants to divide his two properties into small blocks and sell them. He wants the small blocks to all be the same size. What is the largest area of each of these small blocks?

4. What is the definition of an algorithm?

5. Find and describe another algorithm that is used in mathematics.

ESTIMATION - LENGTH

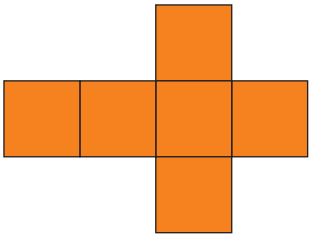
1. ***Estimate*** (in cm) the length of your foot.
2. ***Measure*** the length of your foot.
3. Use the formula below to calculate the percentage error of your estimate.

Error = difference between estimated measurement and actual measurement
= largest value - smallest value

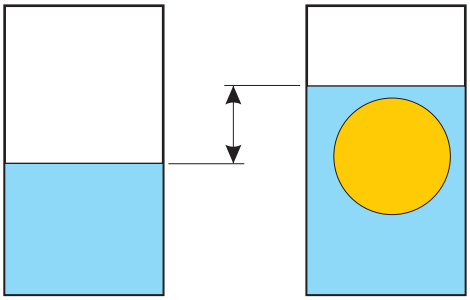
$$\text{Percentage Error} = \frac{\text{Error}}{\text{Actual Measurement}} \times 100$$

4. Choose a room (eg. your bedroom) and ***estimate*** its floor dimensions (length and width) in metres.
5. By putting one foot in front of the other count how many 'foot lengths' go across the length and width of your room.
6. Use the measured length of your foot to calculate an approximation for the length and width of the room.
7. Measure the dimensions of the room using a measuring tape.
8. Find the percentage error of your estimate and 'foot length approximation'.
9. ***Estimate*** the length of one of your paces as you walk.
10. ***Measure*** one of your paces.
11. Calculate the percentage error of your estimate.
12. On an oval throw a ball and ***estimate*** how far you threw it.
13. Walk this distance and count the number of paces.
14. Use the measurement of your pace to calculate an approximation for the distance you threw the ball.
15. Use a measuring tape to ***measure*** the distance of your throw.
16. Find the percentage error of your estimate and approximation.
17. ***Estimate*** the height of a tree, building, telephone pole, etc. Choose an object that is at least 10 metres tall. Explain any comparisons that you used in your estimate.
18. ***Calculate*** the height of this object using a mathematical method. Explain the method you have used.

ESTIMATION - VOLUME



1. Copy and cut out this net of a cube.
2. Measure the side length of each square of the net.
3. Fold it into the shape of a cube.
4. What is the volume (in cm^3) of this cube?
5. Place this cube next to a tennis ball. Use the comparison of the size of these two objects to ***estimate*** the volume of a tennis ball.
6. Find a cylindrical or rectangular container that a tennis ball can be placed in.
(a) Put water in the container.
(b) Mark the level of the water.
(c) Place the tennis ball in the water and push it down until it is totally submersed.
(d) Mark the level of the water with the ball submersed.
(e) Measure (in cm) the difference in water levels.



7. Describe how this difference of water level and the cross-sectional area of the container can be used to calculate the volume of the tennis ball.
8. Measure the diameter of the tennis ball.
9. Find the formula for the volume of a sphere.
10. Use the measured diameter of the ball and this formula to calculate the volume of the tennis ball.
11. Estimate the volume of an egg.
12. How many eggs do you think could be cracked into a 250 mL drinking glass?
13. Use the 'submersing in water' technique above to calculate the volume of an egg?
14. Use this to calculate the number of eggs that could be cracked into a 250 ml drinking glass? What assumption did you make about the thickness of the egg shell?
15. Estimate the volume (in litres) of a basketball?
16. Use the 'submerse in water' technique (if you have a large enough container) and formula to calculate the volume of a basketball.

WATER USAGE

1. ***Estimate*** the amount of water (in litres) that you use while having a shower.
Describe your reasoning used in this estimation.
2. ***Estimate*** the amount of water that is used in a flush of the toilet.
Describe your reasoning used in this estimation.
3. List other uses of water ***in*** the house.
4. ***Estimate*** the amount of water one person uses in the house in one week.
5. ***Estimate*** the amount of water your family uses in the house in one month.
6. List the uses of water ***outside*** your house.
7. ***Estimate*** the amount of water used outside the house in one week during winter.
8. ***Estimate*** the amount of water used outside the house in one week during summer.
9. Find the average of these two figures to find the average amount of water used outside the house in a week.
10. Use these figures to find your estimate of the average total amount of water used by your family in one month.
11. Ask your parents to find a water bill and from that find the amount of water used by your family. Compare this to your estimate. Suggest reasons for any difference.

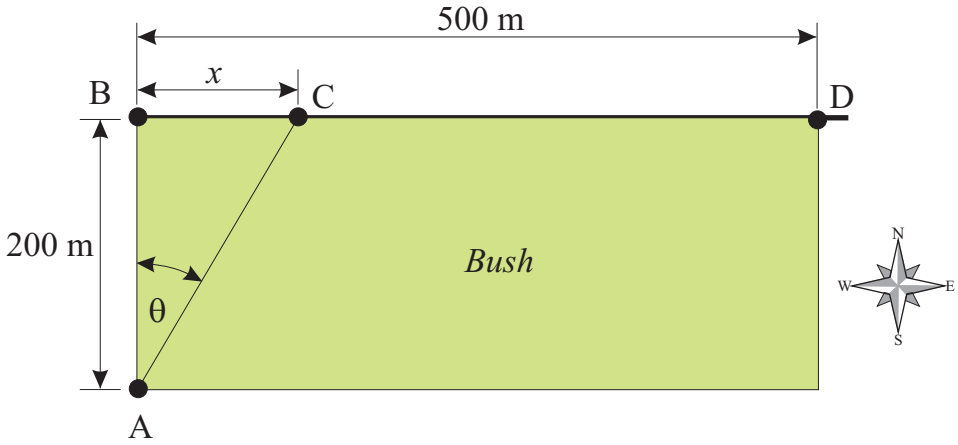
A family is building a house on a rural property where they need to install water tanks for all their household water requirements.
All the rainwater that falls on the roof will flow into these tanks.
The area of the roof of the house is 400 m^2.
The family is two parents and three children.
The average monthly rainfall in millimetres for each month is shown below.

J	F	M	A	M	J	J	A	S	O	N	D
34	32	36	41	55	60	56	58	54	53	38	33

12. How many litres of water are collected in the tanks for every millimetre of rain that falls?
13. Use the monthly rainfall figures to find the average total amount of water (in litres) that would be collected in each month.
14. The owners are trying to work out how much water storage they will need.
They can purchase 15 000 and/or 20 000 litre tanks.
They want to ensure they have adequate storage to last through any periods when they may get little rain but don't want to waste money by buying too many tanks.
Use the figures for the water usage by ***your*** family and the average amount of water collected off the roof of the house being built to suggest how much water storage will be needed.
Give all the reasoning behind your answer.
15. If the water tanks were full, how long could the family last if it did not rain?

BUSHWALKING (PYTHAGORAS AND TRIGONOMETRY

The diagram below is a map.
Bushwalkers are located at point A.
They need to walk to point D.
Point A is 200 m due south of point B.
Point D is 500 m due east of point B.
The shaded region is bush.
BD is a walking track.
The bushwalkers can walk at a speed of 3 m/s in the bush.
They can walk at a speed of 5 m/s on the walking track.



The bushwalkers want to find the quickest route (ACD).

1. Let x = 50 m. Use Pythagoras' Theorem to find the length AC.

2. Use the formula shown here to find the time it would take the bushwalkers to walk from A to C.

$$\text{Time} = \frac{\text{Distance}}{\text{Speed}}$$

3. Find the distance from C to D and the time taken to walk this distance.

4. For x = 50 m, find the total time taken to walk from A to C to D.

5. Repeat this method to find the time taken to walk from A to D for x = 0, 50, 100, 150, ... 500.

6. Present this information in a table and on a graph of '*Time* v x'.

7. What is the value for x that would give the quickest path from A to D?

8. How much quicker is this path than if the bushwalkers walked in a straight line from A to D?

9. Find the angle θ for the quickest path.

10. What bearing should the bushwalkers take from A to trek the shortest path?

BUSHWALKING - SPREADSHEETS

The bushwalking problem (previous page) can be solved using spreadsheets.

1. Put the headings and initial numbers below onto a new spreadsheet.

x = the distance between B and C
AC = the distance between A and C
CD = the distance between C and D
t_{AC} = the time taken to walk between A and C
t_{CD} = the time taken to walk between C and D
t_T = the total time taken to walk from A to D

	A	B	C	D	E	F
1	x	AC	CD	t_{AC}	t_{CD}	t_T
2	0	200				

2. Use the following formulae to complete the second line.

C2=500-A2 (CD = 500 - x)
D2=B2/3 (t_{AC} = AC/3)
E2=C2/5 (t_{CD} = CD/5)
F2=D2+E2 ($t_T = t_{AC} + t_{CD}$)

	A	B	C	D	E	F
1	x	AC	CD	t_{AC}	t_{CD}	t_T
2	0	200	500	66.66667	100	166.6667

3. Use the following formulae and complete the next line.

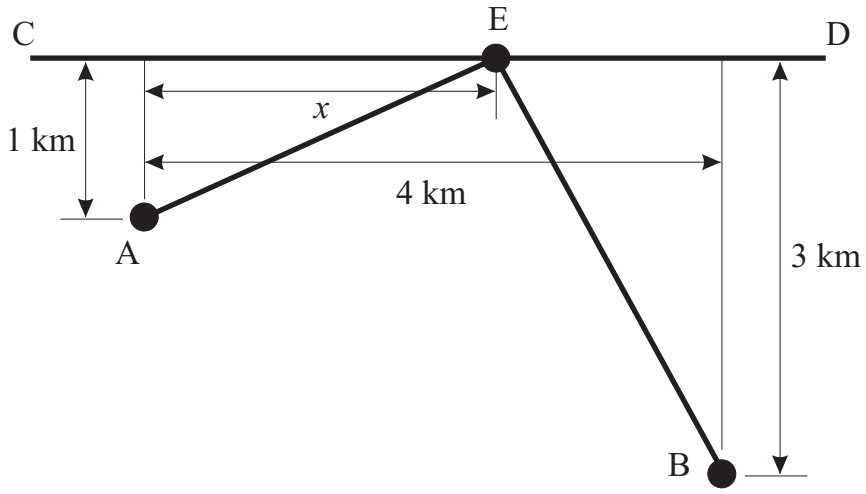
A3=A2+50 (x = 50)
B3=SQRT(200^2+A3^2) ($AC = \sqrt{200^2 + x^2}$)

	A	B	C	D	E	F
1	x	AC	CD	t_{AC}	t_{CD}	t_T
2	0	200	500	66.66667	100	166.6667
3	50	206.1553	450	68.71843	90	158.7184

4. Complete the spreadsheet for all values of x up to 500 by using the '*fill down*'.
5. What value of x results in the shortest time?
6. Print out a graph (chart) of x versus *total time*.
7. The bushwalkers want to find how their walking speed will affect the total time taken and the value of x for the shortest time.
Choose another walking (or jogging) speed for the two sections of their trek from A to D.
Complete the above spreadsheet for these new speeds and find the value of x for the shortest total time taken.

ELECTRICITY LINES (PYTHAGORAS)

The diagram below shows two houses A and B and an electricity line CD.

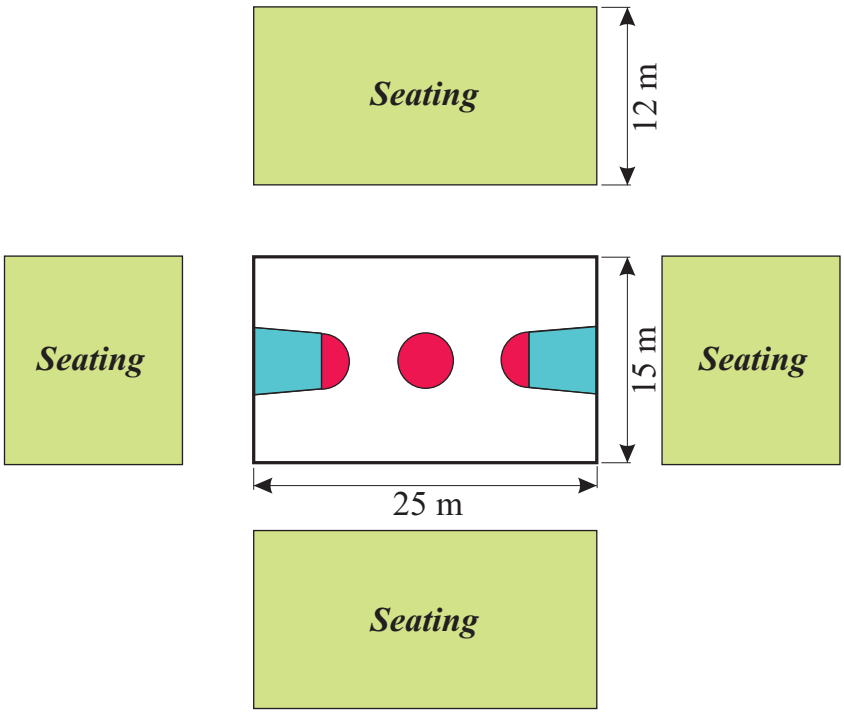


The two houses A and B are both to be connected to the electricity line. To keep the cost to a minimum the electricity supplier plans to add one transformer at point E from which electricity lines will join to the two houses.
The cost of the electricity lines will be $1000 per kilometre.
Your task, as the construction engineer for the electricity supplier, is to find the position of the transformer (x) to make the overall cost a minimum. Find the cost of electricity lines to the two houses.

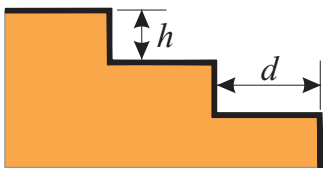
Several methods that may help you are:
Graphical approach
Table of values
Trial and error
Spreadsheet

SEATING IN A BASKETBALL STADIUM

A basketball club wants to build seating around their court.
The seating areas are to be along the sides and ends of the court.
Each seating area is to be 12 m deep.
The diagram below shows the court and seating areas.



The shape of the seating is to be continuous steps as shown here.



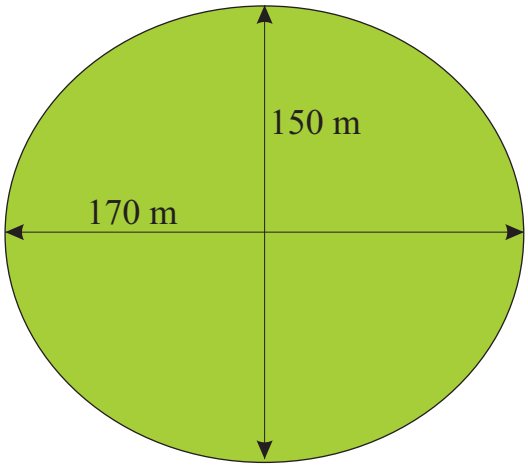
1. Your task, as the architect, is to determine the height, h, and depth, d, of the seating.
Give reasons for choosing these dimensions.

2. Having designed the size of the seating, calculate the number of people that will be able to sit in the seating areas.
Explain any assumptions made in this calculation.

3. How high above the court level is the highest row of seating?

MAINTAINING THE MCG

The approximate dimensions of the Melbourne Cricket Ground are shown here.



1. Use a grid of 1 cm squares (1 cm = 10 m) and sketch the shape of the ground to find its approximate area (in m^2).

2. How many hectares is this?

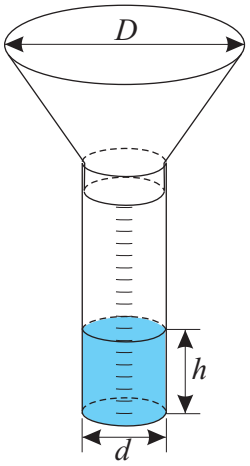
3. The ground is watered several times a week. It requires a total of about 30 mm of water to be applied each week. How many litres of water are required to achieve this?

4. The ground has grass seed applied twice a year at a rate of 35 grams per m^2. How many kilograms of grass seed are required for each application? How many tonnes is this?

5. If the total surface of the MCG was to be relaid using rolls of turf that were 1.5 m wide, what is the total length of turf required?

DESIGN OF A RAIN GAUGE

A rain gauge is used to measure the amount of rainfall. It often consists of a funnel that channels the rainwater into a measuring cylinder.



1. What is the main reason for the funnel?

2. How does the size of the funnel affect the accuracy of the rain gauge?

3. If the diameter of the funnel (D) is 8 cm, calculate the area (in cm^2) of the top of the funnel.

4. If the diameter of the measuring cylinder (d) is 4 cm, calculate its cross sectional area (in cm^2).

5. Convert these two areas to mm^2.

6. State the formula used to calculate the volume of a cylinder.

7. After one millimetre of rainfall, calculate the volume of rainwater (in mm^3) that will collect in the rain gauge.

8. Calculate the height (h) of water that will collect in the rain gauge after one millimetre of rainfall.

9. Calculate the height (h) of water in the gauge after two millimetres of rainfall.

10. Find the value of the ratio D/d for $D = 8$ cm and $d = 4$ cm.

11. Find the value of the ratio h /rainfall for $D = 8$ cm and $d = 4$ cm.

12. Repeat the above calculations for:
(i) $D = 12$ cm and $d = 4$ cm
(ii) $D = 8$ cm and $d = 2$ cm
(iii) $D = 10$ cm and $d = 2$ cm

13. Copy and complete this table.

D (cm)	d (cm)	D/d	h/rainfall
8 cm	4 cm		
12 cm	4 cm		
8 cm	2 cm		
10 cm	2 cm		

14. Describe the relationship between D/d and h/rainfall.

15. For a rain gauge with $D = 6$ cm and $d = 2$ cm find the height of rainwater in the gauge after 4 mm of rainfall.

16. Wally is making a rain gauge with $D = 10$ cm, $d = 2$ cm and a 30 cm measuring cylinder. He has asked you to mark on the cylinder lines indicating every millimetre of rainfall. How far apart should these lines be?

HOLIDAY

You and your family are going to have a holiday in Cairns.
You are booked into a resort from the 20th - 28th of September.
Your parents have decided to drive there and back.
You task is find the following:

1. On what date you should leave home?
2. The major towns/cities that you will pass through on the way there and on the way back. Choose a different route for the return journey.
3. At which towns or cities you will need to stay on the way there and on the way back?
4. How much will it cost in petrol to get there and back?
5. On what date you will return home?

Information you will need to include in your report:

(a) The rate of petrol usage of the car you will be travelling in:
- litres/100 km and km/litre

(b) The price of petrol.
(c) The average speed you expect to be travelling.
(d) The average number of kilometres you expect to travel each day.
(e) List all the major towns/cities you will be travelling through and the distance between them.
(f) List the towns/cities at which you plan to stay overnight and the distance between them.