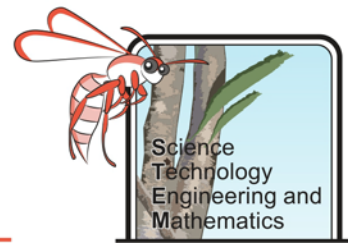
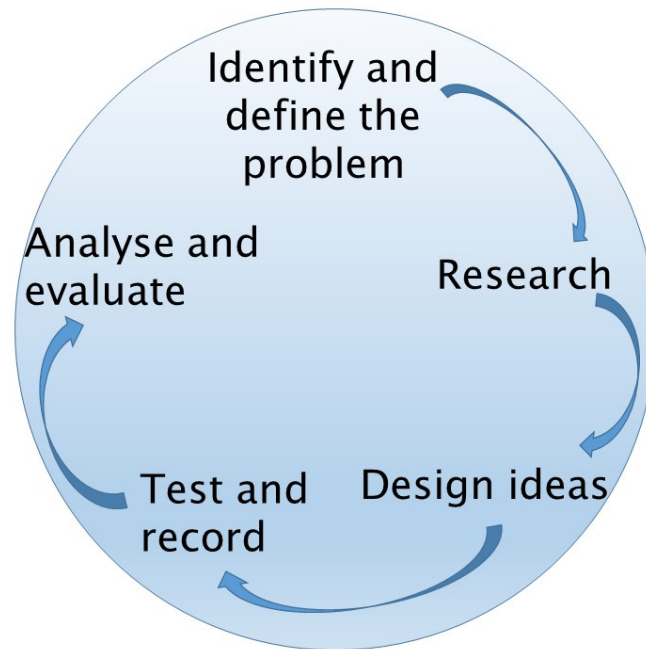


Going for Gold – Student Booklet



The Challenge

Realising that in Western Australia you have a unique opportunity to find a small fortune or at the very least have an adventure, your family decides that their next holiday will be spent fossicking for gold. You know that this could be very hard and also dangerous, so you decide to do some research and investigations in advance to ensure you are well prepared for the undertaking ahead.



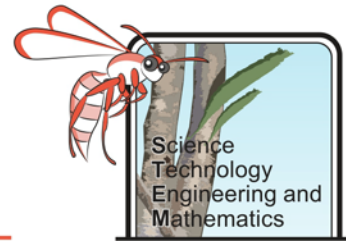
Background Information

The discovery of gold in the Kimberley in 1885 sparked the excitement of many, but it was in 1892 when the Gold Rush of Western Australia really started, with the first big discovery at Coolgardie being announced. Further discoveries in Western Australia, including Mount Charlotte, lead to a population boom with over 100,000 people moving to the state in the following 10 years.

In 2015 – 16 gold was the third largest resource exported by Western Australia in regards to value, with a value of \$10 billion dollars. This equated to 6.27 million troy ounces. The mine which produced the most in this time period was the Super Pit Gold Mine in Kalgoorlie which produced 700, 000 Troy ounces. However, gold is mined all over the state with mines nearly as far north as Port Hedland, stretching all the way down south to Norseman.

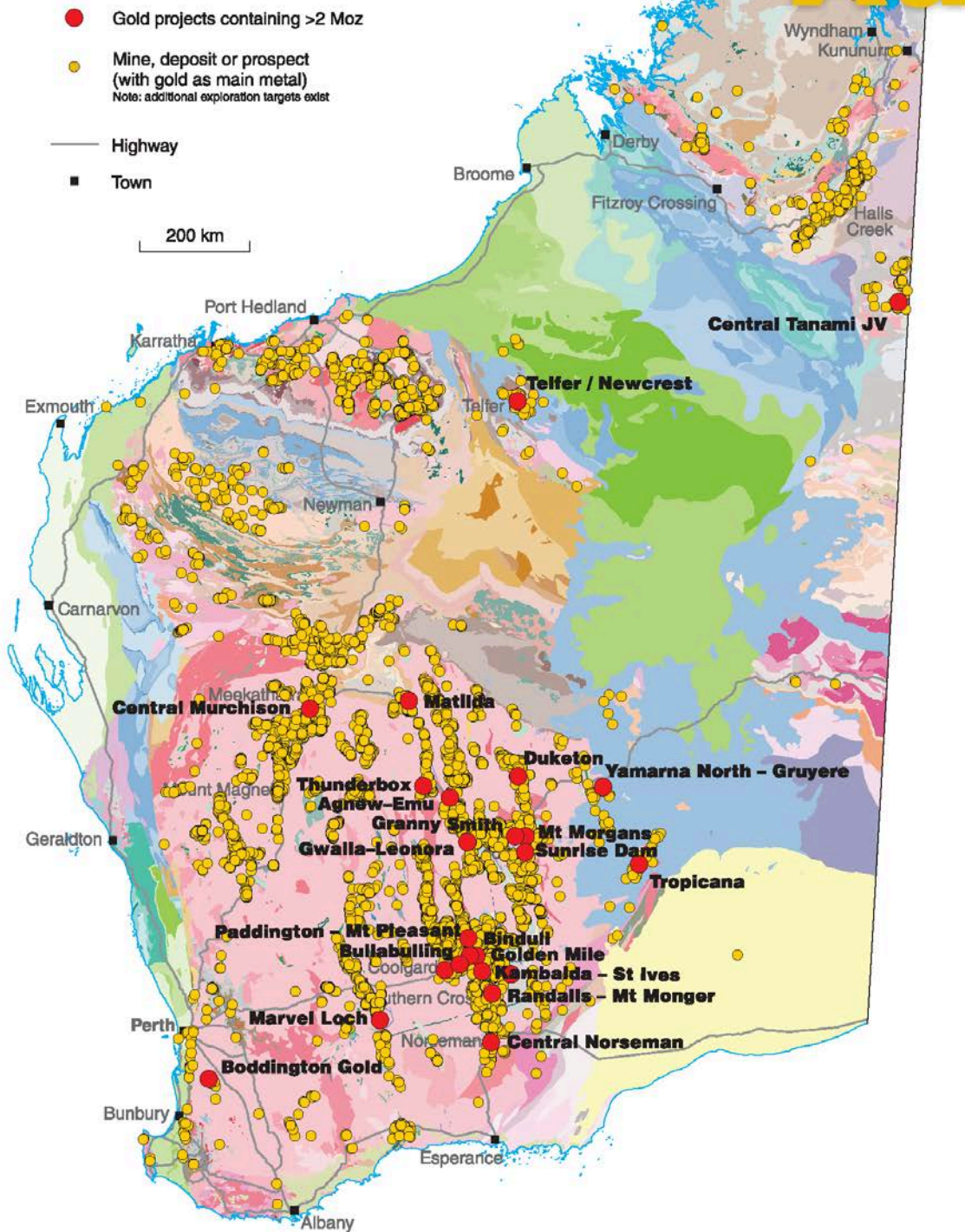
Gold does not usually react with other elements, and so around 70% of it is found as native gold. However, around 20% of it will form compounds with other elements (tellurium, sulphur or selenium) creating minerals known as tellurides. Rocks containing tellurides were initially thought to be fool's gold and were discarded, used as building stone and thrown on walkways (literally paving the streets with gold!) It was only a few years into the

Going for Gold – Student Booklet



gold rush that the tellurides were discovered to be gold bearing. This is what is mined at the SuperPit at Kalgoorlie now.

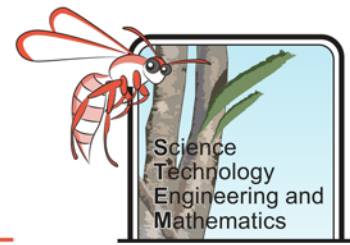
Mines, deposits and prospects



MARCH 2017

Figure 1. Map of Western Australia, showing some key locations where gold has been found (Geological survey of Western Australia, 2017).

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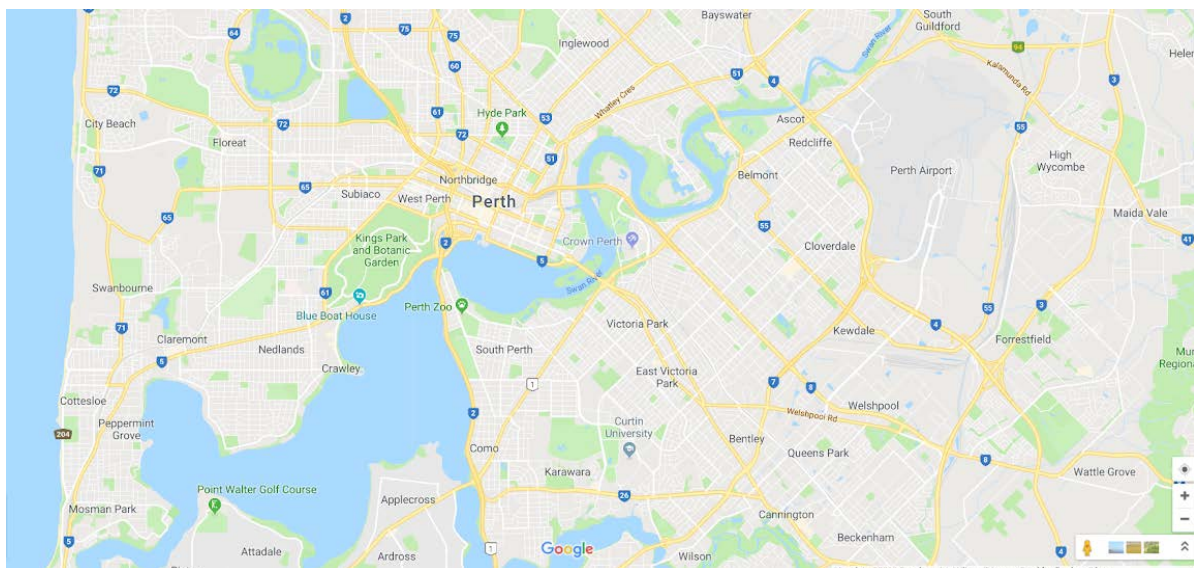


For thousands of years gold has been sought after and used for jewellery and coins all over the globe. However, it has only been in the last hundred years that developments in technology and medicine have led to its other properties being exploited. Nearly all computers and mobile phones will contain small amounts of gold – which is one of the reasons why many phone companies will give you a discount on a new phone if you exchange your old one.

Gold has always been a prized and valuable mineral, even with its market price constantly fluctuating, you can be sure that if you strike gold – you've struck gold!

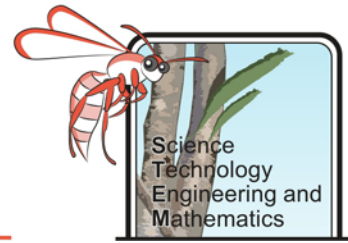
Background Research

1. What is hydrothermal gold?
2. What is secondary or placer gold?
3. Shade areas on the picture below to indicate the most likely areas to find placer gold deposits (hint: think about where the water is going slower).



4. Where in Western Australia are the three largest gold mines found?
5. Which rock types are the gold mines in Western Australia often associated with?
6. How can gold be separated from surrounding rock?
7. What are some of the properties of gold which could assist you to identify it?
8. What properties of gold make it useful for medicine and electronics?
9. Have there been any recent large finds by fossickers, if so where and how big were the nuggets/finds?
10. What is the current price of gold?
11. How much will your holiday cost approximately?
12. How much gold will you have to find to finance your holiday?

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Investigation: How Much is Your Gold Worth?

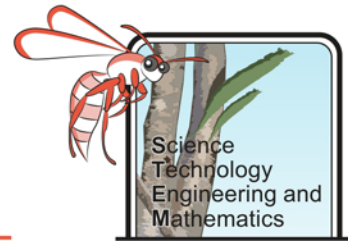
Although you can always be pretty sure that your gold is going to be valuable, the price of gold is always fluctuating. Therefore if you find gold, or have gold you want to sell, it is always worth analysing the markets to decide if it is a good time to sell, or if you might be better off waiting to see if the market price increases.

1. Find an interactive graph online which shows the price of gold over the past 5 years and paste it here – don't forget to add a reference.

2. What is the range for the price of gold over the past 5 years, and when did the maximum and minimum occur?

3. Can you see any patterns in the gold price fluctuation, e.g. seasonal changes, a linear relationship or does it just seem random?

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4. What was the price of gold on today's date for the past 5 years?

Today	
1 year ago	
2 years ago	
3 years ago	
4 years ago	
5 years ago	

5. Calculate the mean price of gold on this day over the past 5 years. (Show your calculations).

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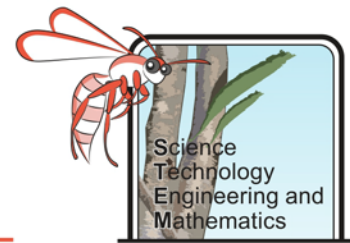
6. Is the price of gold today above or below the mean price on this day over the past 5 years, by how much?

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7. Determine the median and the interquartile range for the price of gold over the past 5 years and create a box and whisker plot.

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8. Calculate the percentage difference from the mean for the max and min values.

Max	Min

The price of gold will depend on its Karat value, and its weight. The purest gold is 24 Karat gold, the lower the number the less pure the gold is. Gold is measured in troy ounces (ozt), there are 31.1 grams in a troy ounce.

9. If 31.1 g = 1 ozt, how many troy ounces are in a kilogram of gold? (Show your calculations).

How to calculate the price of your gold – EXAMPLE.

Price of gold today (spot price)	\$ 1700
Weight of gold	5 grams
Karat	14 k

Step 1. Divide the karat value by 24, and multiply by 100 to find the percentage of pure gold content.

$$14 / 24 = 0.583$$

$$0.583 \times 100 = 58.3\%$$

Therefore the percentage of pure gold in 14 k is 58.3%

Step 2. Divide the spot price by 31.1 to determine the price of 1 gram of pure gold (24 karat)

$$1700 / 31.1 = \$54.66$$

Step 3. Multiply the price per gram of pure gold, by the percentage of gold content as a decimal

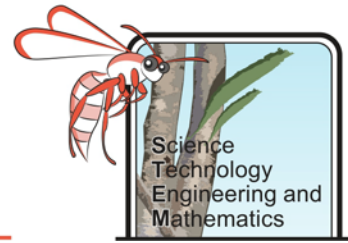
$$\$54.66 \times 0.583 = \$31.87$$

Therefore the price per gram of 14 K gold is \$31.87

Step 4. Multiply the price per gram by the number of grams you have.

$$\$31.87 \times 5g = \$159.35$$

So the total value of the gold is \$159.35



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Find the price of the following, using today's spot price:

- a) 1 g of 24 k gold
- b) 10 g of 18 k gold
- c) 20 g of 14 k gold

	A	B	C
Step 1			
Step 2			
Step 3			
Step 4			
Price			

Calculate what the price of samples A, B and C would have been at their highest value on this day, and at their lowest values (use your answers from question 5).

Highest price	A	B	C
Step 1			
Step 2			
Step 3			
Step 4			
Price			

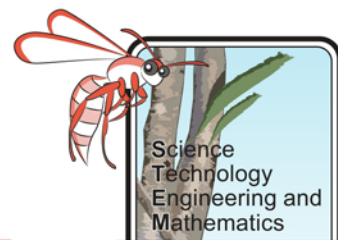
Lowest price	A	B	C
Step 1			
Step 2			
Step 3			
Step 4			
Price			

Evaluation

What is the range in price for each sample?

A	
B	
C	

If you only have a small piece of gold do you think it is worth holding onto for the market value to increase, or does it not really make a big difference? Use your previous answers to justify your explanation.



Investigation: Creating a Risk Assessment

Objective

Going fossicking for gold should be an adventure, but it will be tough and could be dangerous. It is very important that you are well prepared and have completed a risk assessment.

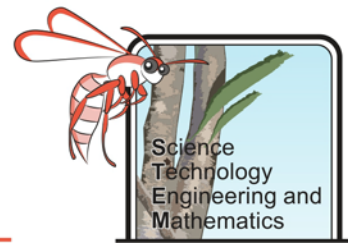
Scoring the risk

Before going on a field trip or excursion it is common to use a risk assessment matrix to decide if the activity is too risky to carry out. The likelihood of the risk happening combined with the severity of the outcome if it happens creates the overall risk rating. The risk rating is a score between 1 – 12, with 1 being the lowest risk rating and 12 being the highest.

Risk assessment matrix					
Risk rating key		LOW	MEDIUM	HIGH	EXTREME
		Acceptable OK to proceed	As low as reasonably practical Take mitigation efforts	Generally unacceptable Seek support	Intolerable Place event on hold
		Severity			
		ACCEPTABLE	TOLERABLE	UNDESIRABLE	INTOLERABLE
		Little to no effect on event	Effects are felt, but not critical to outcome	Serious impact to the course of action and outcome	Could result in disaster
Likelihood	IMPROBABLE Risk is unlikely to occur	LOW 1	MEDIUM 4	MEDIUM 6	HIGH 10
	POSSIBLE Risk will likely occur	LOW 2	MEDIUM 5	HIGH 8	EXTREME 11
	PROBABLE Risk will occur	MEDIUM 3	HIGH 7	HIGH 9	EXTREME 12

Figure 2. Risk assessment matrix, combining the likelihood of the risk occurring with the severity of the outcome.

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Example - Severity

Acceptable	Tolerable	Undesirable	Intolerable
Minor injury or first aid treatment Example: Insect bite Cutting knee Hit finger with geological hammer	Injury requiring treatment by doctor Example: Getting a small piece of metal stuck in your eye Dropping rock on toe and losing toenail	Major injury requiring time in hospital. Example: Falling in cavern and breaking spine/ bones Severe dehydration	Death of a person or multiple major injuries.

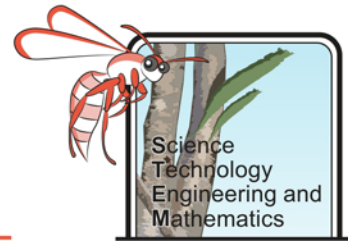
To complete a risk assessment consider what are the main dangers of fossicking in Western Australia. How severe are the risks and what is the likelihood of it happening? Then ensure that you have made it clear how you can avoid the risks occurring. An example has been done for you.

Hazard	What could happen	Severity	Likelihood	Risk rating	How to avoid it
Remote locations with very similar scenery.	Get lost and become severely dehydrated.	Undesirable	Improbable	6 – Medium risk	Always tell people where you are going, take a map and compass and carry a Personal Location Beacon (PLB) or EPIRB.

Extension - Digitising Safety

Design an algorithm that could be used for an app to allow people to determine their event or outing's risk rating.

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Investigation: Rock Identification

Objective

To create a resource which will enable you and others to identify different rock types, in particular those which are commonly linked to where gold is found in Western Australia, and explain how their appearance is linked to their formation.

Equipment

- Array of rock samples
- Hand lenses

Method

1. Note how the rocks feel: light/ heavy, smooth/ rough, crumbly/consolidated and record in a table.
2. Make visual observations about the rocks e.g. colour, shiny/ dull, crystals/grains (and their size), layers/no layers, contains fossils or not – add these observations to your table.
3. Research what type of rocks gold is commonly found in or near in Western Australia.

Results and Analysis

- 1) Using your observations try to identify your rocks – the WASP app or Rock ID poster should help.
- 2) Create a resource to assist you in identifying rocks that may be indicators of nearby gold that you can use out in the field. Include photos, descriptions and types to assist you.

Evaluation

- 1) Why is it equally as important to know what rocks that may contain gold look like as those which are unlikely to contain gold?

- 2) What equipment would you bring with you on a field trip to help you identify rock types?

Investigation: Determining Densities



Figure 3. Archimedes reportedly cried "Eureka! Eureka!" after he stepped into a bath and noticed the water level rising. He realised that the volume of water displaced must be equal to his volume. (Arlindi, 1999)

Objective

To determine the density of different rocks and evaluate how useful density could be as a method of identifying rocks while exploring for gold.

Useful links: video on how to measure the volume of an irregular shape:

<https://www.youtube.com/watch?v=e0geXKxeTn4>

Equipment

- Range of rock samples
- Weighing scales
- 2 x ice cream tubs
- Beaker
- Tray
- Sand
- Measuring beaker/cylinder (this will depend on size of samples)

Method

1. Use the scales to find the mass of each sample and record it in a table.
2. Fill the ice cream container full of water and place it in the tray.
3. Put a sample into the ice-cream container, so that the water overflows into the tray.
4. Pour the water in the tray into the measuring beaker to determine the volume of water displaced, this is equal to the volume of the rock ($1 \text{ ml} = 1 \text{ cm}^3$) and record in a results table.

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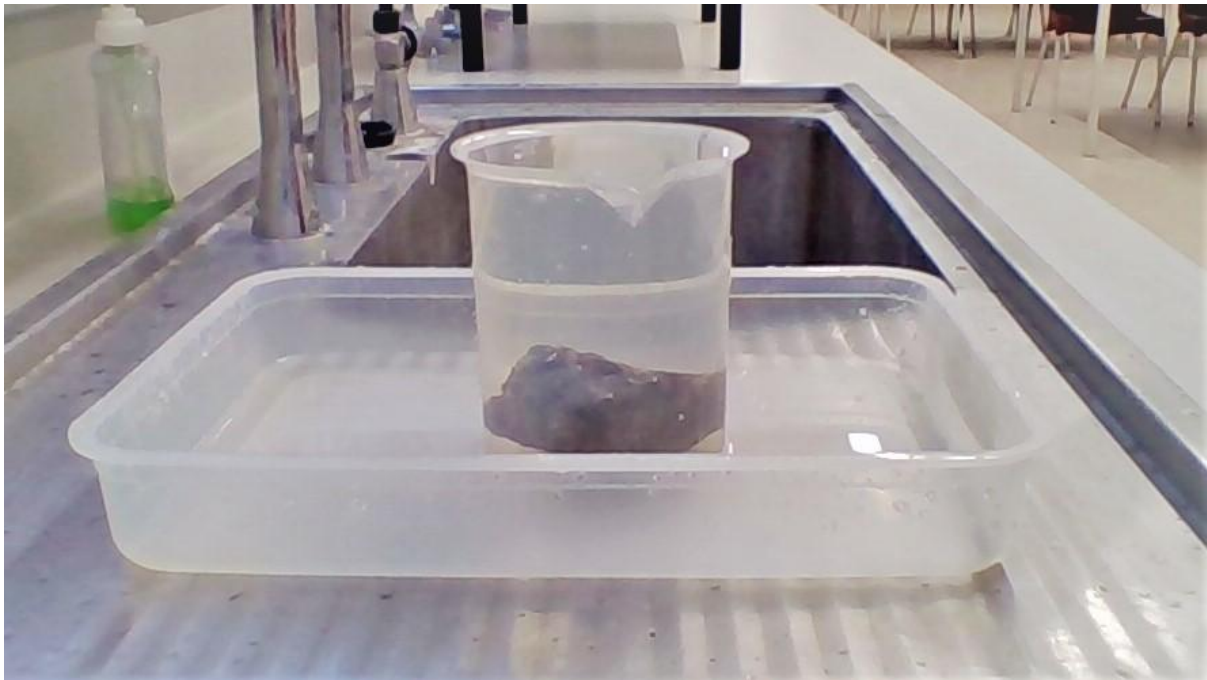


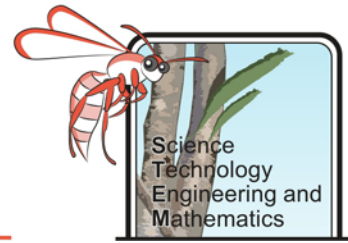
Figure 4. Determining the volume of an irregular shape by placing it in a beaker full of water and then measuring the volume of water which has been displaced into the tray below it.

Note: if you are using small samples, you could just put them in a plastic measuring beaker half filled with water and note how much the water rises when the sample is placed inside, subtracting the difference. Or if you have regular shaped samples you could find the volume mathematically.



Figure 5. If you have a smaller sample you can measure the difference in the level of water before and after a rock is placed into the beaker.

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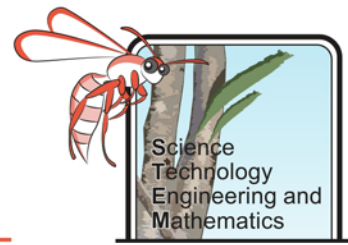
5. Compare your density calculations to densities of rocks found online – how do they compare?

6. Why are the densities of a particular rock type (e.g. granite) given as a range, rather than a fixed value?

7. How useful do you think density is as a way of identifying a rock type, and would you use it in the field as a means of determining rock type?

8. Could measuring the densities of rocks types found in the field assist you to find gold?

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Investigation: Panning for “Gold”

Objective

To be able separate materials of different density, and understand the principles behind gold panning.

Equipment

- Sand and gravel
- Iron filings or denser small pieces of material to represent gold (of small gold pieces of gold leaf)
- Tray
- Gently curved bowl/ lightweight wok
- Tweezers

Method

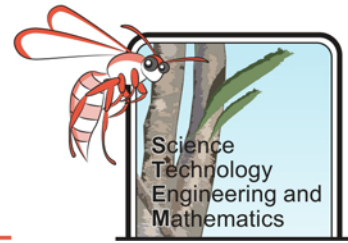
- 1) Pour some sand, gravel and the material representing gold into the tray until it is around 3 cm high and mix very well.
- 2) Pour some water into the tray so it is covering the mixture by around 3 -5 cm
- 3) Scoop out some of the mixture and water into your bowl and give it a good swirl – here is a good video on how to pan for gold:
<https://www.youtube.com/watch?v=ZZMowySFpQc>
- 4) Gently tilt the bowl away from you in the water, and allow the water to wash some of the light sediment away.
- 5) Pick out any large pieces of gravel you can with your fingers.
- 6) Repeat steps 3 and 4 until only the very fine sediment is left, gently tilt it and – if you have any “gold” it should become visible.
- 7) Use your tweezers to take out the “gold” and put it on some paper towel to dry out. Be careful it doesn’t blow away.
- 8) Keep going until you are rich!

Results and Analysis

1. How much did your “gold” weigh?

2. What is the price per gram of gold today?

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3. Calculate how much your “gold” is worth.

4. How long did you spend fossicking (in hours)?

5. Research: what is the minimum wage in Australia?

6. At your current rate of fossicking have you managed to find enough “gold” to pay yourself the minimum wage?

7. At your current rate how long would you have to fossick for to make \$1000?

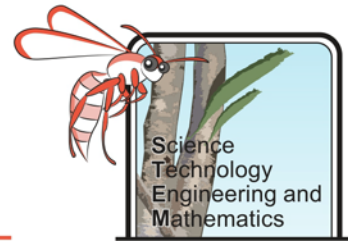
Evaluation

1. What were the strengths and weaknesses of your technique?

2. Can you come up with any design improvements?

3. Do you think many people got rich panning for gold? Explain your answer referring to your own investigation and your knowledge of how gold is formed.

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Investigation: Designing a Dry Blower

Objective

Panning for gold using water is not particularly viable in Western Australia, therefore for your adventure to succeed you will need to design a dry blower (also known as dry washer in USA) to bring with you.

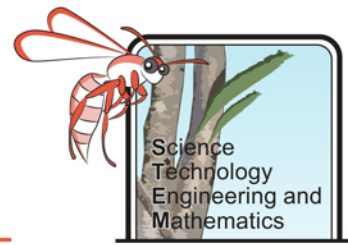
Specifications

The dry blower needs to be portable so that you can take it on your adventure with you, so therefore must be able to fit into the boot of your car/back of your trailer. Remember the aim of the adventure is to make money – so you should keep the cost as low as possible, perhaps you can recycle old, unwanted items.

Method

1. Research what a dry blower is, and how it works.
2. Draw a labelled diagram to show the key components.

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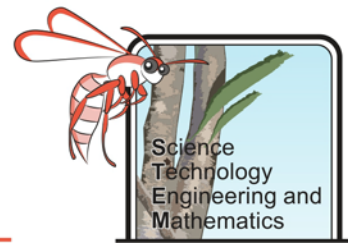
3. What is the function of each of the key components?

Component	Function

4. Research other DIY dry blower designs, and compare their strengths and weaknesses.

Design (link)	Strengths	Weaknesses

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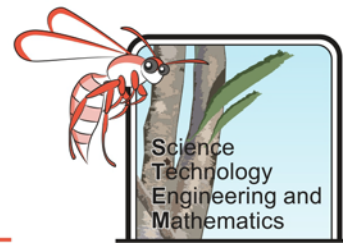
5. Brainstorm replacement materials that could be used to build a dry blower.

Component	Replacement suggestion 1	Replacement suggestion 2	Replacement suggestion 3

6. Draw and label design ideas, comparing the pros and cons of them.

Design	Pros	Cons

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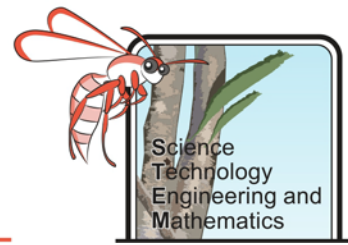


Design	Pros	Cons

7. Write a plan for how you will make your chosen design, ensuring you have completed the risk assessment table. Show this to your teacher and make any necessary changes before making the product.

a. Equipment and tools needed:

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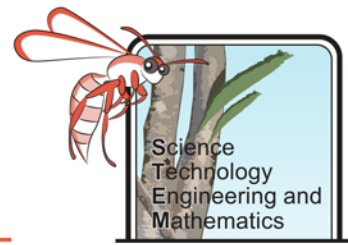


b. Method/ Steps:

Risk Assessment

Hazard	Risk	Prevention
e.g. cutting equipment to size	Could cut fingers/hand	Use equipment with care and under supervision. Keep focused. Use the right cutting tools.

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Testing the design

Equipment

- Sand and gravel
- Iron filings or other materials to act as “gold” pieces

Method

- 1) Weigh how much of each material you have and record this in a table under the heading “before”
- 2) Mix all the “ingredients” together thoroughly.
- 3) Slowly add them to your dry blower allowing it time to separate the mixture.
- 4) Once the mixture has been separated weigh how much of each material you have and put in the table under the heading “after”.

Results and Analysis

1. How much gold did your dry blower manage to pick up?

2. What percentage of the gold added to the mixture did you end up with at the end?
Show calculations.

Evaluation

1. How well did your design work? Did you manage to catch lots of “gold” using your design?

2. What were the strengths and weaknesses of the design?

3. What are your suggestions for improvement to the design?
