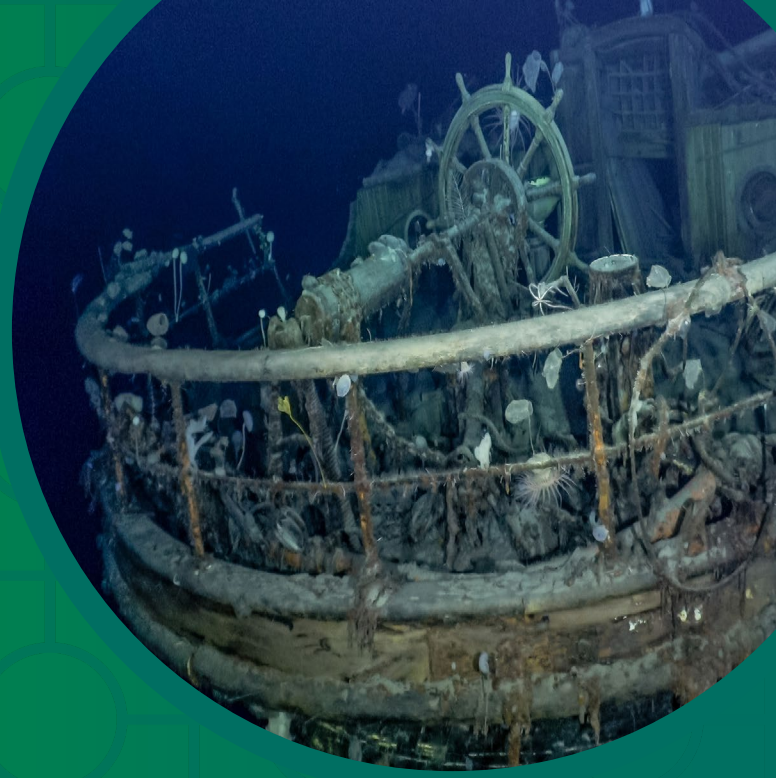
11–14 years

Shipwrecks: a lateral thinking problem



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A lateral thinking problem

There are two shipwrecks.

One is in deep water and the other is in shallow water.

The one in deeper water is less rusty.

Why?

Today you will…

1. Develop higher order thinking skills including lateral thinking and creative thinking.
2. Design a valid investigation which models one of the factors that might affect the rate of rusting at different depths below sea level.

What is a lateral thinking problem?

Lateral thinking problems do not have a straightforward answer. You need to be creative and 'think outside of the box' to find the solution.

Here is an example:

Anthony and Cleopatra lie dead on the floor, in a pool of water. How did they die?

Ask your teacher questions that can be answered yes or no to discover what happened to Anthony and Cleopatra.

Investigate

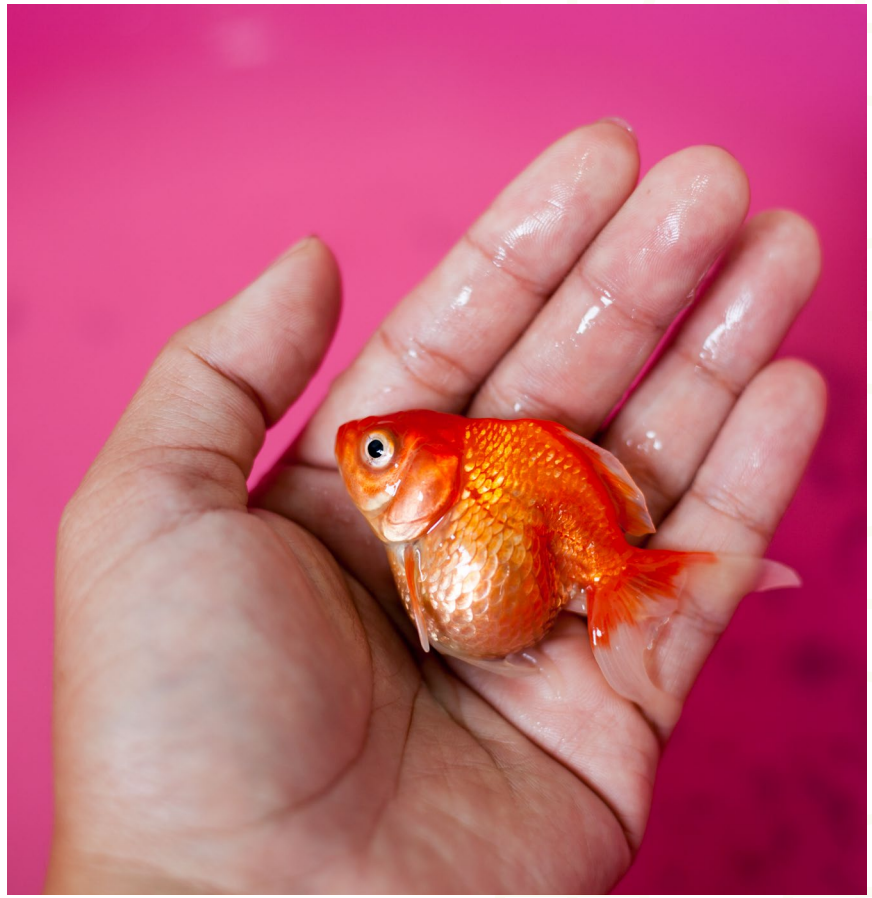
Try some of these questions:

- Were Anthony and Cleopatra murdered?
- Did they drown in the water?
- Did Anthony and Cleopatra both have the same cause of death?
- Did they die of natural causes?
- Do Anthony and Cleopatra have any physical injuries?

The solution

Anthony and Cleopatra are goldfish.

They died when the bowl they were living in fell from the shelf that it was sitting on.



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Did you ask the right questions to get to the answer?

Shipwrecks: a lateral thinking problem

There are two shipwrecks. One in deep water and the other in shallow water.

The one in deeper water is less rusty.

Why?

What are some possible solutions to this lateral thinking problem? Think about the factors that affect the rate of rusting.

What additional information would you need to solve the problem?

Prior knowledge check

Which materials corrode via 'rusting'?

a. Iron and copper b. Iron and glass

c. Steel and copper d. Iron and steel

What conditions are required for rusting?

a. Heat b. Water

c. Oxygen d. Salt

What factors can speed up the rate of rusting?

a. Heat b. Water

c. Oxygen d. Salt

Possible solutions

Some lateral thinking solutions you may have thought of:

- The deep shipwreck was made of wood/aluminium/better painted etc.
- The deep shipwreck was in fresh water and the shallow shipwreck was in salt water.
- The deep shipwreck was carrying a cargo of zinc or magnesium metal.
- The shipwrecks have been there for different lengths of time.
- Divers visit the shallow shipwreck and add oxygen to the water.
- Fish excretion changes the pH of the seawater.

You may have thought of many others, if so well done.

Is it a valid test?

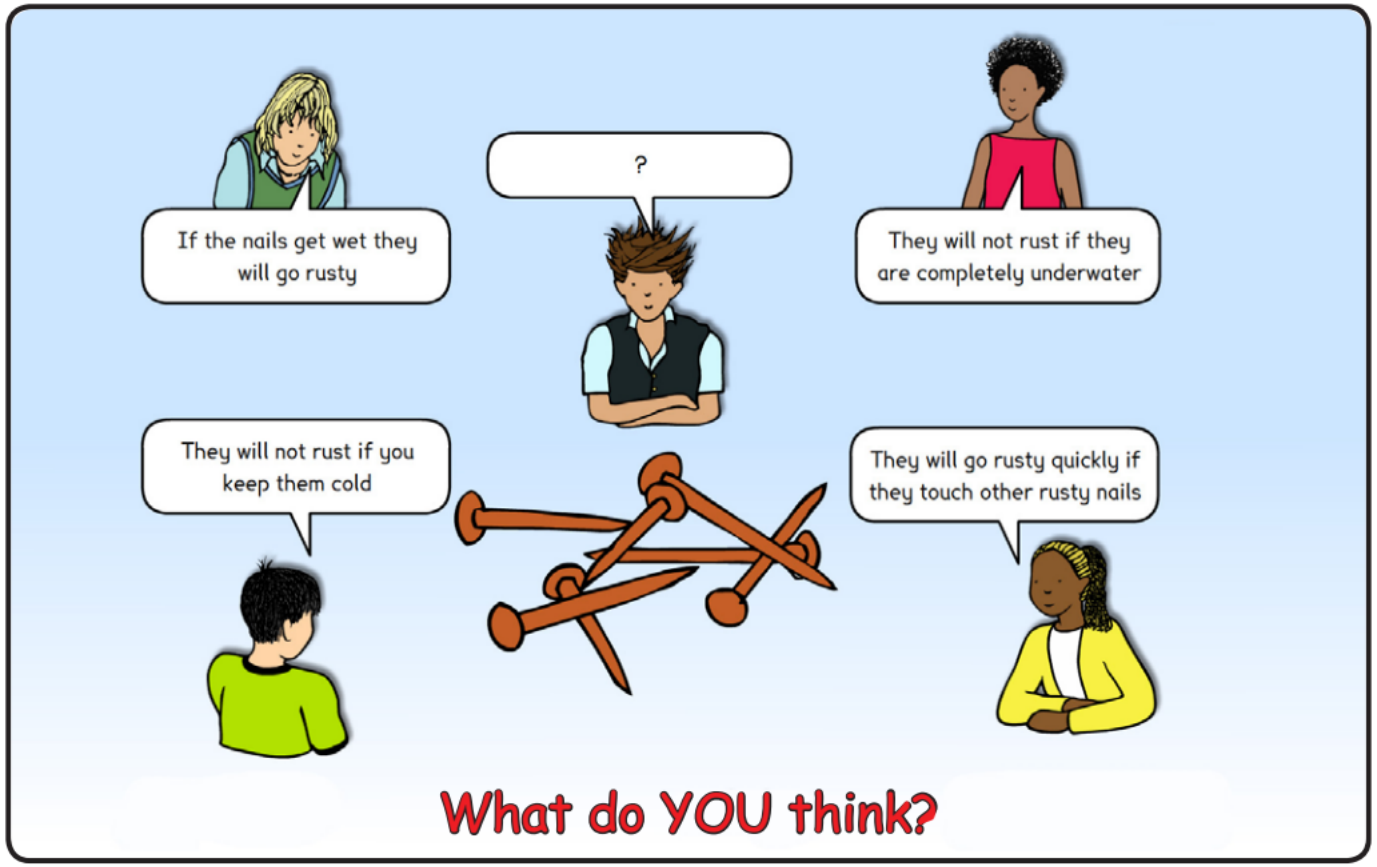
Now let's consider what explanations could work if this was a 'valid test' – ie the ships are identical and the only factors about the seawater that change are those that depend on depth.

A valid test:

- Two identical ships with identical cargoes are sunk in seawater.
- One sinks in shallow water and the other in deep water.

Design a concept cartoon with four possible reasons for which shipwreck rusts faster.

What is a concept cartoon?



A concept cartoon features a simple image of the problem and presents 4 or 5 different opinions or solutions.

The purpose of a concept cartoon is to promote discussion which will lead to an explanation.

Hints and tips

Some hints for possible reasons in the concept cartoon:

- The shallow seawater is warmer.
- The shallow seawater has more oxygen dissolved in it.
- The shallow seawater is moving with a faster current or is stirred about more.
- The concentration of salt in solution varies with depth.

The best explanations take the reasoning further and explain why.

Further thinking

The best explanations take the reasoning further and explain why…

- The shallow seawater might be warmer.
- The shallow seawater might have more oxygen dissolved in it.
- The shallow might get stirred about more.
- The shallow seawater might have a higher/lower concentration of salt.

Improve your concept cartoon by adding an explanation.

Choose the prediction and explanation that you think are most likely.

Applications in real life

Who might be interested in how the rate of rusting changes with depth at sea?

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Real-life context

Applications in real life

Who might be interested in how the rate of rusting changes with depth at sea?

- Salvage companies who may want to predict the extent of corrosion in sunken ships.
- Ship owners who want to predict the working life of their vessels.
- Oil rig companies who want the iron legs of the rigs to remain strong enough to support the rig.
- Naval historians who want to date artifacts or shipwrecks.

Planning

Plan an investigation to determine how one of the following factors affects the rate of rusting of iron shipwrecks:

- temperature,
- the salt concentration,
- the dissolved oxygen,
- the amount of stirring.

Some things to think about:

- Real shipwrecks are unlikely to be available, so you will need to model the complex situation with something more simple… a nail perhaps?
- You need to consider how you will measure the amount of rusting.
- Rusting takes a long time. Your experiment needs to run for at least a week, perhaps longer.

How to plan an investigation:

1. Write a hypothesis.
2. Identify the variables.
3. Make a prediction.
4. Decide what equipment you need.
5. Write a method.

Use the template if you need support.

Plan an experiment