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|  |  |  |  | **Year 11 Integrated Science** | | |  |  |
|  |  |  |  | **Task 7** | | |  |  |
|  |  |  |  | **Refining Rocket Fuel with Distillation** | | |  |  |
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| **Name:** | | **Teacher:** |  | **Score:** | **/31** | | |  |
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Introduction:

The move to ‘greener’ fuel sources is progressing in an attempt to mitigate the damage to the environment due to an enhanced greenhouse effect. One of the main contributors to the enhanced greenhouse effect is the burning of fossil fuels as our primary source of energy.

Ethanol has been suggested as a sustainable fuel source in the future because it can be produced easily through the fermentation of sugars through yeast. The specifics of this reaction are not the focus of today’s experiment; the important thing is that the products of this reaction are an ethanol and water mixture. The maximum of concentration of ethanol is about 15 % per volume, higher than this and the ethanol will kill off the yeast. For this reason, we need to utilise a suitable technique to separate the mixture and purify the ethanol.

Distillation is an extremely useful technique that is used to purify and separate liquid – liquid and liquid – solid mixtures. There are two common types of distillation –simple and fractional distillation. Simple distillation is used to separate the components of a liquid- liquid mixture if the boiling points of the liquids are very different (70 °C). If the boiling points of the liquids are closer together, then fractional distillation *should* be used.

Our experiment involves separating a mixture of ethanol and water. The boiling points of these two liquids are 78 °C and 100 °C respectively. Because we are ~~not~~ rocket scientists, we are limited in the equipment we have available to us and will use to simple distillation extract ethanol to use as a fuel source.

1. Draw a labelled diagram of the distillation apparatus in the space below (4 marks)

Observations of the *impure* mixture: (3 marks)

Odour? Colour? Flammable? Anything else?

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After you have set up the distillation apparatus similar to that on display, follow the next steps of the experimental procedure:

1. Start the stream of water through the condenser tube so that it flows from the bottom to the top, out of the outlet and into the sink.
2. Add the impure mixture into the distilling flask and replace the rubber stopper and thermometer.
3. Heat the mixture carefully, slowing increasing the temperature of the hot plate (and water bath) until the mixture starts to vaporise.
4. Record the temperature at which the distillate liquid starts to condense and be collected into the graduated cylinder.
5. Record the temperature and volume of distillate collected at 30 s intervals.

Complete the following table of results (4 marks)

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| --- | --- | --- |
| Time (minutes) | Temperature of mixture °C | Volume of Distillate mL |
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Observations of the *purified* mixture: (3 marks)

Odour? Colour? Flammable? Anything else?

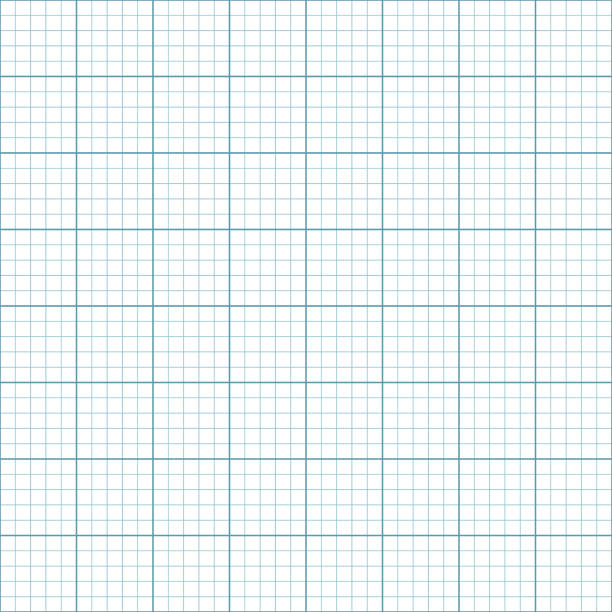
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Create an appropriate graph of time and temperature using the data you have collected (5 marks)



What was the temperature at which the mixture first starts to boil? (1 mark)

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Explain how the water bath was at 100°C (the water was boiling) but the ethanol/water mixture only reached ~80 °C? (2 marks)

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Why do you think we use a water bath for the distillation process is it completely necessary? (2 marks) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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Describe the process of distillation and explain why we are able to utilise the separation technique to purify our ethanol and water mixture. (4 marks)

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Make a statement about the effectiveness of simple distillation to separate ethanol and water. Include reference of boiling points, your observations of the starting and final mixtures, and an estimate of the purity of ethanol in the final distillate. Was it effective in purifying rocket fuel? (3 marks)

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