 Assessment task – properties of water practical task

Stage 6 Science Earth and Environmental Science

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Outcomes

Working scientifically

EES11/12-3 Conducts investigations to collect valid and reliable primary and secondary data and information

Students:

* employ and evaluate safe work practices and manage risks (ACSES031)
* use appropriate technologies to ensure and evaluate accuracy

EES11/12-5 Analyses and evaluates primary and secondary data and information

Students:

* derive trends, patterns and relationships in data and information
* assess error, uncertainty and limitations in data (ACSES004, ACSES005, ACSES033, ACSES099)
* assess the relevance, accuracy, validity and reliability of primary and secondary data and suggest improvements to investigations (ACSES005)

EES11/12-7 Communicates scientific understanding using suitable language and terminology for a specific audience or purpose

Students:

* select and apply appropriate scientific notations, nomenclature and scientific language to communicate in a variety of contexts

Knowledge and understanding

EES11-10 Describes the factors that influence how energy is transferred and transformed in the Earth’s systems

Students:

* investigate the unique properties of water that make it such an important component of the Earth’s systems, including: (ACSES024)
  + boiling point
  + ability to act as a solvent
  + density
  + thermal capacity
  + surface tension

Learning across the curriculum

* Critical and creative thinking
* Literacy
* Numeracy

Teacher notes

The task should be timetabled so that students are able to complete the task in one lesson. It is recommended that the task take 90 minutes to complete. This involved students spending 15 minutes at each station with 15 minutes at the end to check and finalise responses.

Materials List (per group)

| Station 1  Density | Station 2  Boiling Point elevation | Station 3  Thermal capacity of water | Station 4  Capillary action and surface tension | Station 5  Solubility |
| --- | --- | --- | --- | --- |
| * 10mL measuring cylinder * balance * 2 x ice cubes * 2 x 250mL beakers * 100mL acetone | * 2 x 250mL beakers * 2 x Bunsen burners * 2 x tripods and gauze mats * 2 x heatproof mats * 2 x thermometers (preferably digital) * Water * 50mL measuring cylinder * 10g salt (NaCl) | * 1 x Bunsen burner * 1 x heat proof mat * 1 x tripod * 1 x pipe clay triangle * 1 x metal tongs * 1 x damp cloth * 2 x waxed paper cups * Water | * 3 x 100mL beakers * Detergent * Paper clips * Microscope slide * Greased paper * Plastic pipette * 5c piece * Ebonite rod * Silk cloth | * 16 x Test tubes * 100mL Water * 100mL Kerosene (or equivalent) * 2 x spatulas * 500mL waste beaker * Samples of   + Sugar   + Salt   + Oil   + Calcium carbonate   + Ethanol   + Urea   + Stearic Acid |

Task

Students will conduct a series of first-hand investigations to investigate the unique properties of water, including:

* ability to act as a solvent
* density
* thermal capacity
* surface tension

The purpose of task is to perform a series of practical investigations to determine the physical and chemical properties of water.

Water has unique physical and chemical properties that make it essential for life. In this investigation you will examine a range of specific physical properties that are responsible for water’s unique behaviour. You will investigate the unique properties of water, including:

* the ability of water to act as a solvent
* density of water
* thermal capacity of water
* surface tension of water
* adhesion and cohesion.

On completion of this investigation, you will be able to:

* Calculate, from gathered data, the density of liquid and solid water
* Conclude from experimental data, what effect antifreeze and salt have on the boiling points of water.
* Identify the forces within water that are responsible for capillary action (surface tension)
* Compare the solubility of different everyday substances in water and kerosene.

You will rotate through all 5 stations. You will have 90 minutes to complete all 5 stations. It is recommended that you spend 15 minutes at each station and use 15 minutes at the end to check and finalise responses.

Practical assessment task

Safety note: Usual precautions when undergoing practical tasks should take place, including the wearing of personal protective equipment and the use of risk assessments to minimise and mitigate hazard and risk. In this practical task, students must wear goggles and a lab coat for the duration of the task. Students must wear gloves when they complete Station 5.

Station 1 – density of water and ice

1. Using the 10mL measuring cylinder, measure our five different volumes of water and measure the mass of each sample. Record all measurements in Table 1.
2. Place one cube of ice into a beaker containing 100mL cold water. Place the other cube into a beaker containing 100mL acetone
3. Estimate the percentage volume of ice cube that is protruding above the surface of the water. Perform the same estimation for the acetone. Record your results in Table 2.

Results

Record your results in the tables below. (4 marks)

Table 1. Density of Liquid Water

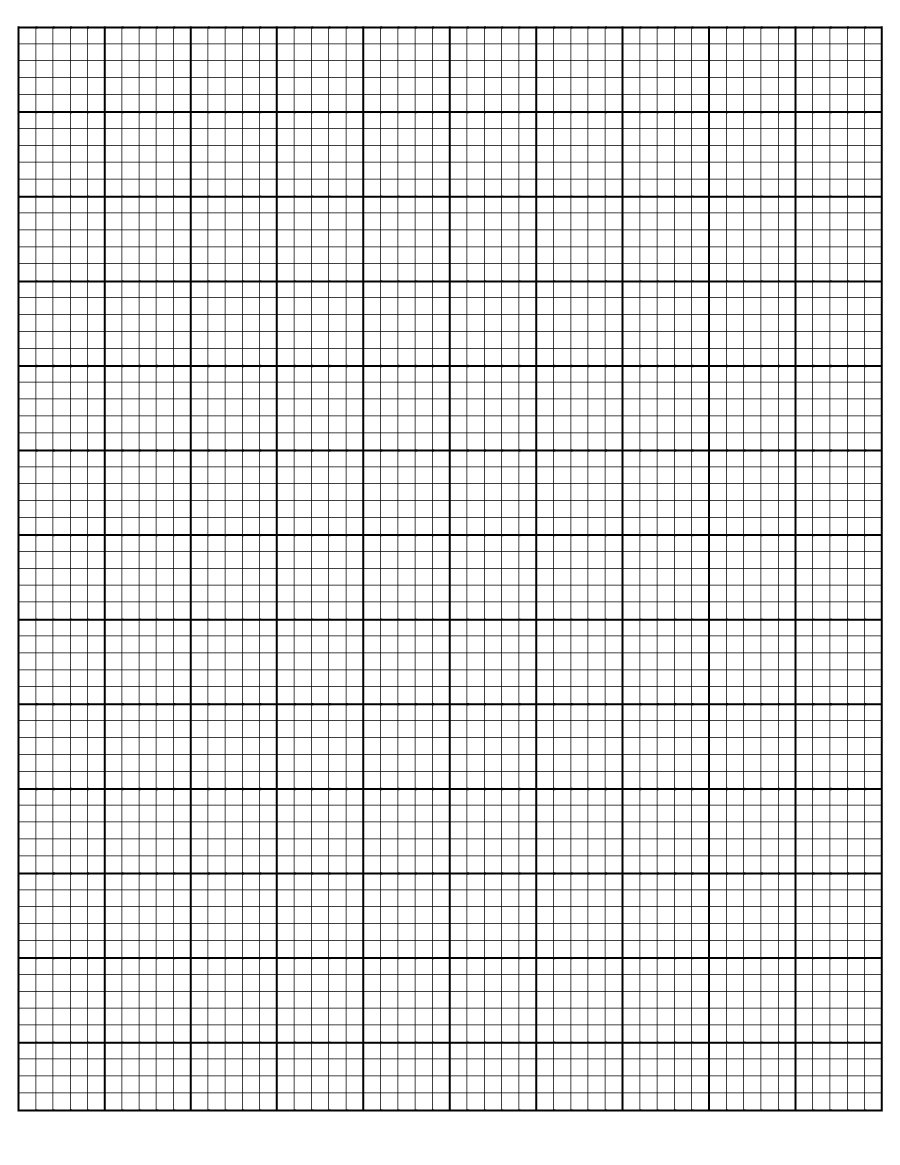
| Sample number | Volume of water (mL) | Mass of water (g) |
| --- | --- | --- |
| 1 |  |  |
| 2 |  |  |
| 3 |  |  |
| 4 |  |  |
| 5 |  |  |

Table 2. Density of ice

| Test | Observations |
| --- | --- |
| ice in water |  |
| ice in acetone |  |

Discussion and Analysis of Results

1. From Table 1, plot the collected data (mass on the vertical axis) on graph paper. Draw a line of best fit between your plotted points. From the line of best fit, calculate the value of the slope (gradient) of your graph - this is the density of liquid water. Hence write down a value for density of water in g/mL. (4 marks)



Gradient (slope) of the line can be found using the formula [gradient = rise/run]. The density of water is

1. From Table 2, make a generalised statement about the density of ice relative to water. (1 mark)

1. Hypothesise a reason why, in nature, it is essential for ice and water to have a different density. Give an example to support your answer. (2 marks)

1. In very cold climates, like the Australian Alps, car radiators may be damaged if the temperature drops below 0°C. Propose an explanation for this observation. (2 marks)

Station 2 - Boiling Point of Water

1. Set up two Bunsen burners, retort stands, tripods and gauze mats as shown in image 2.1 below.
2. Fill both beakers with 100mL of water.
3. Place 10g of salt into one of the beakers. Stir to ensure the salt dissolves
4. Using the thermometers provided, take an initial temperature reading of both beakers of water.
5. Place each beaker onto a gauze mat over a Bunsen burner.
6. Ignite both Bunsen's and turn them to the blue flame. Begin timing.
7. For each beaker, take a temperature reading at every 1 minute interval.
8. Heat each beaker until they are both boiling. This should take no longer than 10 minutes.

picture of experimental setup. A close up of a tripod, gauze and beaker with thermometer. 



Image 2.1 Experimental setup

Results

Record your results in the tables below. (3 marks)

Table 3. Boiling Point Elevation

Water

| Time (min) | Temperature (degrees Celsius – oC) |
| --- | --- |
| 0 |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

Water and salt

| Time (min) | Temperature (degrees Celsius – oC) |
| --- | --- |
| 0 |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

Discussion and Analysis of Results

1. Referring to your data, outline how the addition of salt affected the boiling point of water. (2 marks)

1. At sea level (100 kPa), what is the expected boiling temperature of water? (1 mark)

1. Mt Everest is the highest peak on Earth. Hypothesise what would to happen to the boiling point of water on Mt Everest. Give a reason for your answer. (2 marks)

1. Why would the addition of salt to water be useful in activities such as cooking? (2 marks)

1. Would the results in this investigation be considered reliable? Justify your answer. (2 marks)

1. Suggest two ways this investigation could be improved. (2 marks)

Station 3 - Thermal Capacity of water

1. Place a Bunsen Burner on a heatproof mat. Light the Bunsen and adjust it to a small blue flame.
2. Using metal tongs, hold one of the waxed paper cups over the flame. Time how long it takes for the cup to catch fire. Allow the cup to burn or extinguish it by placing it on the heatproof mat and covering it with a damp cloth. Turn off the Bunsen.
3. Place a pipe clay triangle on top of a tripod and set it over the Bunsen burner.
4. Half fill the second waxed cup with water and carefully rest it on top of the pipe clay triangle.
5. Ignite the Bunsen and adjust it to a small blue flame.   
   NOTE: ensure the centre of the flame is one the base of the cup. The flame must not play on the sides of the cup above the water level.
6. Allow the flame to continue heating the cup. Time how long it takes for the water to begin to boil. Check the final temperature with the thermometer.  
   NOTE: there may be a little charring of the cup around the rim or the base. The cup should not catch fire.

Results

Record your results in the tables below.

Table 4. Thermal Capacity of water

|  |  |  |
| --- | --- | --- |
| Scenario | Time taken to burn | Observations |
| Empty waxed cup |  |  |
| Waxed cup with water |  |  |

Discussion and Analysis of Results

1. Define the term “thermal capacity”. (1 mark)

1. Propose a reason as to why the empty paper cup caught flame whilst the cup containing water did not. (1 mark)

1. Does air or water have a higher thermal capacity? Justify your answer. (2 marks)

1. Given the thermal capacity of water, explain why it would be an advantage for an organism to live in the ocean rather than on land. (2 marks)

Station 4 – surface Tension of water

1. Place one drop of water on a clean microscope slide. Describe your observations.
2. Place two separate drops of water on a piece of greased paper. Now move the greased paper carefully so that the drops touch. Describe your observations
3. Fill a large beaker with water until the water is almost spilling over. Carefully float a paper clip on top of the water and record your observations  
   Note – if you are having difficulty floating the paper clip, place a small section of tissue under the clip, before placing it in the water, and then use a pencil to push the paper down into the water.
4. Using the beaker with the floating paper clip, add a few drops of detergent on top of the water. Record your observations.
5. Fill another beaker with water until the water is almost spilling over and sprinkle a little chalk dust on the surface of water. Add a few drops of detergent on top of the water and record your observations.
6. Using a plastic pipette, see how many drops of water can be placed onto a 5c coin without the water flowing over. Record your results.
7. In a small beaker, mix 20mL of water and 5 mL of detergent. Using this mixture, repeat step 7.

Table 5. Surface tension

| Test | Observations |
| --- | --- |
| Water on glass |  |
| Water on greased paper |  |
| Paper clip floating on water |  |
| Paper clip floating with detergent added |  |
| Water drops on 5c coin |  |
| Water/detergent mixture droplets on 5c coin |  |

Discussion and Analysis of Results

1. Define the term surface tension. (1 mark)

1. What is responsible for causing the surface tension in water? (1 mark)

1. What does detergent do when added to water? Use evidence from your observations to support your statements. (2 marks)

1. A water droplet has a spherical shape on Earth. What do you think causes this shape? (1 mark)

1. With reference to a specific example, explain how surface tension is important in the biosphere. (2 marks)

Station 5 - Water as a solvent

1. Transfer a small quantity of each test sample into its own test tube (approximately the size of a match head).
2. Add 10mL of distilled water to each tube.   
   Note – at this stage, you may be able to observe a wavy layer of lines forming at the interface of sample and water. This optical effect is caused by an alteration in the reflective index of the water by dissolving of the solute.
3. Placing your thumb over the mouth of the tube, and gently shake the test tube to aid the dissolving process.
4. Observe each test tube. Assess the relative solubility of the solute as ‘soluble’, ‘slightly soluble’ or ‘insoluble’ and record this information in the results table.
5. Repeat the experiment using kerosene as the solvent.  
   NOTE: you must wear goggles and gloves during this investigation. All test tubes containing kerosene should be emptied into a waste beaker.

Results

Table 5. Solubility

| Test sample (solute) | Solubility in Water | Solubility in Kerosene |
| --- | --- | --- |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

Discussion and Analysis of Results

1. Identify any substances that dissolved in water but not kerosene. (1 mark)

1. Identify any substances that dissolved in kerosene but not water. (1 mark)

1. Draw an annotated diagram to show the relationship between the terms solute, solvent and solution. (3 marks)
2. Water is sometimes referred to as the Universal Solvent. Hypothesize why this might be the case. (1 mark)

1. Explain, with examples, why it is important for water to be an effective solvent in nature. (2 marks)