Physics

Introduction

In my physics lessons I will be investigating what effects the speed of heating water when heated by an immersion heater. For the investigation I have to take into account the following, but only one of them I am able to change. Type of container, Type of liquid (substance in container), Amount of water, length of coil and voltage applied. All these variables will have different affects on the speed in which the immersion heater is able to heat the water. But what I already know is that heat can pass through water by convection. Convection current works when an atom or molecule is given energy to vibrate or move around, they eventually spread apart and escape from the colder liquid becoming less dense. This is why the warmer and more energetic atom rises throughout the liquid giving energy to surrounding atoms or water molecules. If this atom has enough energy it is able to escape from the liquid turning into a vapor, but soon the hot particle will eventually cool and sink, this is called convection current.

Decision

The variable that I have chosen to change is the amount of water I will do this by measuring specific amounts using a measuring cylinder.

Range of amounts

- 10ml
- 15ml
- 20ml
- 25ml
- 35ml
- 40ml

Prediction

I predict that the less water there is in the test tube then the quicker the water will gain its energy from the immersion heater, I think this will happen because the less amount of water will be using a smaller convection current so the process will be finished faster.

For the larger amounts of water I predict it will take longer to heat up because there is greater amount of atoms and molecules that need to gain their energy.

Predictions (scientifically)

Out of all the ranges of amounts I've predicted that 10ml amount will heat the quickest because theirs less atoms and molecules to provide with energy to heat the water. Also the liquids remains at the same volume unless the temperature changes. So if the 10ml amount is heated and reaches a high temperature the volume is likely to change when the water particles at the surface have sufficient energy to break away from the surface. The water gains this energy and move faster and faster expanding the liquid. Until the most energetic particles escape from the surface of the liquid as a vapour as it gets warmer. (Water becomes less dense and rises). So I think that the water warmed by the current flowing through the coil is less dense than the surrounding colder water, the warm water will rise through the

colder water to the surface. So the 10ml amount is likely to be heated quicker because theirs less water for the heat to travel through and the electrons will be hitting into the atoms making the atoms passing on the heat faster and more frequently.

I've also predicted that the 40ml amount will take the longest to heat because the coil will have to gain enough energy to vibrate or move a large amount of atoms or molecules. But because of the fixed time (5 minutes) there isn't much time for the water molecules to gain enough energy. When it has started its convection currents and the atoms have come less dense and rose to the top their most likely to lose this heat considering there isn't a lid on top of the plastic beaker. The other cold surrounding atoms will add to the difficulty in the large amount of water keeping its heat.

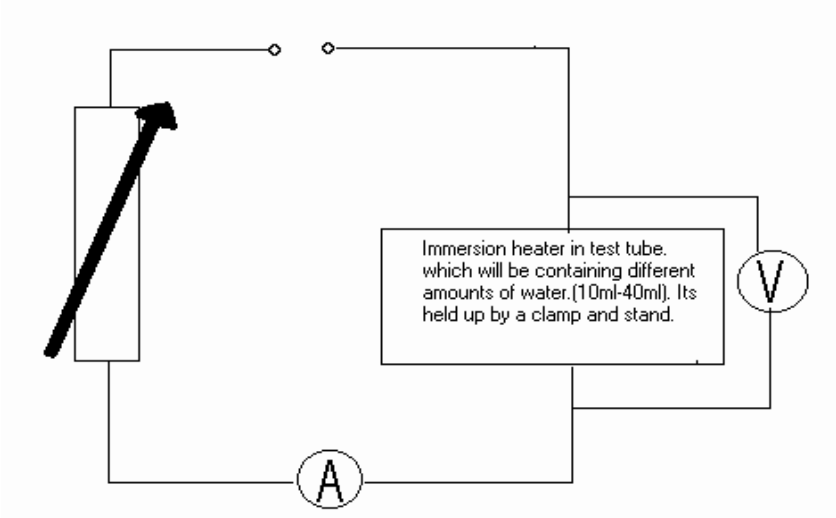
Experiment

The experiment will be carried out during class will be using the following apparatus:

- Beaker
- Water
- Immersion
- Heater
- Thermometer
- Source of insulation
- Power source
- Wires
- Clamp
- Stand
- Ammeter
- Voltmeter
- Variable resistor

For the experiment I will have to keep the following the same so that my results I gather are more reliable and accurate; The thickness of the test tube, if this is changed then there's going to be affects on how much heat is kept in or lost from the tube. Also I will be using the same apparatus for the experiment right the way through by storing my equipment in a safe place, so the wires, power source and test tube is always the same. Each reading that we take from the thermometer will be taken at eye level with one person either side of the thermometer so that the results are seen more clearly. This is more likely to keep the results accurate. We will repeat each set of results 3 times and give each set an average so then if we notice any errors they can be corrected and we are left with more reliable.

Diagram



To try and keep this experiment as accurate as possible I am going to try and keep the voltmeter and ammeter to certain values:

- Voltmeter: 5Volts.
- Ammeter: 2.5 Amps.

From my trial experiment I noticed that the voltage applied to heat up the water will have to be high enough to make an impact on the immersion heater so it can provide enough heat to the surrounding cold water. If there isn't enough energy supplied then the immersion heater doesn't warm up quickly enough to show a range of results after the 5minutes.

Safety

If the heat of the water reaches boiling point stop the process and mention in the results table that it reached 100 degrees.

Make sure the clamp is tightened enough. So test tube and thermometer is secure.

Wear safety goggles.

After the boiling tube has finished its 5minute interval remove it from the clamp using tongs so burns are avoided.

Results

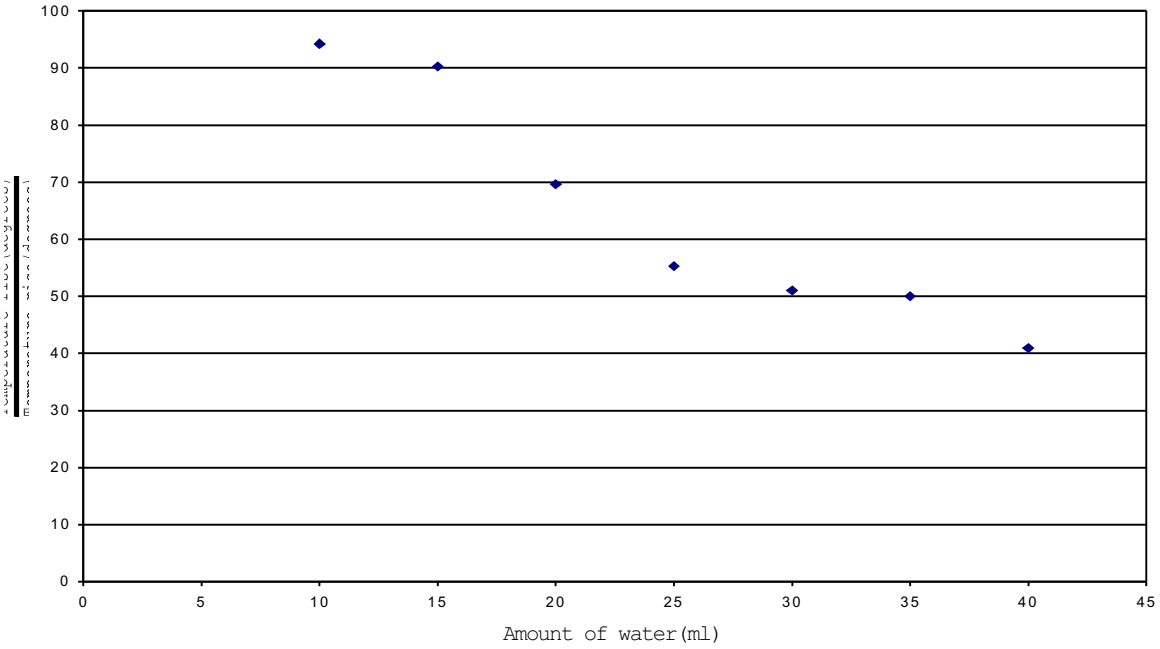
	Temperature After 5 minutes(degrees)					
Volume (ml)	1(Degrees) C°	2(Degrees) C°	3(Degrees) C°	Average(%) Degrees C°	Amps(A)	Volts(V)
10ml	94	95	95	95	2.5	5
15ml	91	89	91	90	2.5	5
20ml	69	70	70	70	2.5	5
25ml	54	56	56	55	2.5	5
30ml	52	52	50	51	2.5	5
35ml	51	50	49	50	2.5	5
40ml	41	41	41	41	2.5	5

Each result's in this table have been given an average so end results are more reliable. With my results table I am able to work out the resistance using this formula:

(volts)Voltage÷(Amps)Current =Resistance(Ω)

5Volts ÷2.5Amps =2Ω

Throughout the experiment I kept the voltage and current the same so that the resistance didn't change.



Graph

The graph tells me that the more water that is in the test tube the longer it takes to heat. The less amount of water the shorter amount of time that it takes. So from my results and graph I believe I have gathered enough results to prove that my conclusion is right.
So the pattern in my results is the more water in the test tube the longer it takes to heat up.
This happened because when the atoms became less dense they floated to the top but not with enough energy, also being surrounded by a large amount of cold water that affected the atom's journey to the surface. But for the small amounts the energy from the coil was enough to keep the atoms constantly vibrating or moving around. So the water reached a greater temperature at a quicker speed, this is shown by the tangent that has been drawn by the bottom of the graph, it shows how fast the speed of the immersion heater warming the water. The gradient represents how steep the graph is and this shows that the speed of the immersion heater is affected by different amounts of water.
My conclusion was the same as my prediction and the pattern showed by my graph showed that my prediction is correct.

Evaluation

My overall experiment came to a reasonable success because it was easy to obtain fairly accurate and reliable results. My prediction was correct and I was able to think scientifically why this was. From my results and graph there was a noticeable pattern that proved the effects of a immersion heater on different amounts of water. There might have been some errors such as reaction time (on stopwatch) or the volts or amps reading went up or down at the certain point by fraction. The experiment could have been also been improved by using a MultiMate that is hi-tech equipment that will give me more accurate readings because it is able to work out readings at 1 or 2 decimal places. We carried out the experiment in a typical way there were no computers or special equipment used so we had to mostly rely on out eyes and reaction times so this is not reliable considering reaction times aren't spot on. But I used my reaction time for all of them so it makes it a fair test. If I was to do the experiment again I would use one type of computer equipment

called “digital thermometer” because it shows accurate readings to 1 or 2 decimal places and stops the person from having to look at it from eye level, considering it has a LCD screen. The results could have been kept more accurate also by adding some sort of silvery material (foil) around the outside and top of the test tube to make improvements. This would reflect the heat that is escaping by convection and so the heat wouldn’t be lost.

Also the average results that I gathered had no faults or errors so they are accurate and reliable as possible, each result was very close to the line of best fit, none of the results are floating away from the line.