**NAME:**

**HEATING VARIOUS LIQUIDS**

**PROBLEM:**

(a) Do the temperatures of liquids heated under the same conditions change at the same rate or does the rate depend on the type of liquid?

(b) How does the temperature change of a liquid heated under the same conditions depend on the mass of the liquid?

(c) Does the temperature change depend on the amount of heat added to a liquid?

**HYPOTHESIS:** (make your own hypothesis for each case)

1

2

3

**MATERIALS:**

3 different liquids ( water, vegetable oil, and alcohol)

balance

Pyrex beaker for each liquid

hot plate

beaker tongs

thermometer (3)

stirring rod (3)

timer

graph paper

**PROCEDURE:**

PART A

1 Make a chart to record the temperature of the three samples of liquid every 30s for ~10 minutes. The first reading will be time 0.0 s

|  |  |  |  |
| --- | --- | --- | --- |
| TIME | SAMPLE 1 TEMP | SAMPLE 2 TEMP | SAMPLE 3 TEMP |
| 0.0 s | 22° C | 22° C | 22° C |
| 30.0 s | 23° C | 28° C | 35° C |

2 Devise a method to measure out equal masses of each liquid ( ~100 g ) used to solve problem (a). Place each liquid in its own beaker. Try to ensure they all have the same initial temperature.

3 Set the hot plate to a medium hot setting. This must be kept constant the entire experiment. Also this hot plate must be used to heat all three liquids

4 Measure the temperature of the first liquid to be tested. Place the beaker on the middle of the hot plate and start your timer. Stirring constantly measure the temperature every 30 s until the temperature reaches a high but safe value (~60°C). The thermometer bulb should not touch the bottom of the beaker when the readings are taken

5 Record your results on the chart

6 Repeat steps 4 & 5 for the other two liquids

PART B

1 Make a chart to record the temperature of the three samples of liquid every 30s for several minutes. The first reading will be time 0.0 s

|  |  |  |  |
| --- | --- | --- | --- |
| TIME | sample 1 temperature | sample 2 temperature | sample 3 temperature |
| 0.0 s | 22°C | 22°C | 22°C |

2 Measure out a sample approximately 200 g of each liquid and place in a Pyrex beaker trying to ensure they all have the same initial temperature

3 Set the hot plate to a medium hot setting. This must be kept constant the entire experiment. Also this hot plate must be used to heat all three liquids

4 Measure the temperature of the first liquid to be tested. Place the beaker on the middle of the hot plate and start your timer. Stirring constantly measure the temperature every 30 s until the temperature reaches a high but safe value (~60°C). The thermometer bulb should not touch the bottom of the beaker when the readings are taken

5 Record your results on the chart

6 Repeat steps 4 & 5 for the other two liquids

PART C

1 Make a chart with the time required to heat three samples of liquid to a temperature of ~40°C and the time required to heat the same sample to ~ 60°C for example

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| time required for SAMPLE1  to reach 30°C | time required for SAMPLE1  to reach 60°C | time required for SAMPLE2  to reach 30°C | time required for SAMPLE2  to reach 60°C | time required for SAMPLE3  to reach 30°C | time required for SAMPLE3  to reach 60°C |
| 670 s | 1240 s | 340 s | 790 s | 456 s | 980 s |

2 Measure out a sample approximately 200 g of each liquid and place in a Pyrex beaker trying to ensure they all have the same initial temperature

3 Set the hot plate to a medium hot setting. This must be kept constant the entire experiment. Also this hot plate must be used to heat all three liquids

4 Measure the temperature of the first liquid to be tested. Place the beaker on the middle of the hot plate and start your timer. Stirring constantly measure the temperature every 30 s until the temperature reaches a high but safe value (~60°C). The thermometer bulb should not touch the bottom of the beaker when the readings are taken

5 Record your results on the chart

6 Repeat steps 4 & 5 for the other two liquids

**ANALYSIS:**

PART A

1) On a sheet of graph paper, plot the heating curve for all three liquids from PART A of the lab. Temperature should go on the y axis ( do you know why ?) Label each line on the graph

2) Which liquid had its temperature increase most rapidly? Most slowly?

3) Do the temperatures of the liquids depend on the type of substance being heated?

4) How did your results compare to that of your hypothesis?

5) Use Kinetic Theory to explain your results.

PART B

1) On a sheet of graph paper, plot the heating curve for all three liquids from PART B of the lab. Temperature should go on the y axis ( do you know why ?) Label each line on the graph.

2) Compare this graph to the one in PART A of this lab

3) How does the temperature change of the liquids heated under the same conditions depend on the mass of the liquid?

4) Use Kinetic Theory to explain your results.

PART C

1) Compare the times required to heat the liquids to the 2 temperatures.

2) Does the quantity of heat affect the temperature of a liquid

3) Is the time required to heat the liquid to 30°C proportional to the time required to heat the liquid to 60°C. Explain any differences.

4) Using Kinetic Theory explain how the quantity of heat and temperature are related.

**CONCLUSION:** (form a conclusion for each part of the experiment and relate it to the equation Q=mc\_T)

**LESSON PLAN**

**PURPOSE**:

To understand that different materials absorb and release heat with different capacities and the factors that affect heat transfer to materials.

**REVIEW/PREVIEW**

* Review the safety rules when using hot plates and heating materials
* Ensure everyone has safety glasses and aprons at all times
* Employ the proper use of equipment when handling hot liquids
* Point out that alcohol is very flammable and tell the students the location of the fire extinguisher and eye wash station
* Demonstrate the measuring of mass of a liquid on the digital balance and the importance of the tare button each time
* Remind the students not to stir with the thermometer but rather the stirring rods

**OBJECTIVES:**

1) Students are to verify experimentally that the amount of heat energy transferred to a substance varies with (i) the kind of substance (ii) the mass and (iii) the temperature change

2) Students will have an opportunity to plot a heating curve of temperature against time.

3) Students will employ proper safety procedures during the lab

**INPUT/ MODELING**

The teacher will actively walk around the room and monitor students lab practices and understanding of the task

**ACTIVITIES**

The students will perform the lab in three separate sections and record observations and results in a table form

**GUIDED PRACTICE**

After the labs completion the teacher will go over the results with the students to help ensure accuracy of results and understanding of concepts

**CLOSURE**

Students will form conclusions about the effects of heat transfer to materials as well as describe any experimental errors that may have occurred