

Name \_\_\_\_\_

## Experiment 2.2 Calorimetry

Purpose To measure the specific heat capacity of a metal object

### Method

1. Heat  $\frac{1}{2}$  beaker of water on a burner
2. Weigh the metal object to the nearest gram ( $m_{\text{metal}}$ )
3. Place the metal object in the water on the burner
4. Place one Styrofoam cup within another to make a calorimeter
5. Weigh the empty calorimeter ( $m_{\text{calorimeter}}$ )
6.  $\frac{1}{2}$  fill the calorimeter with water
7. Weigh the calorimeter with the water ( $m_{\text{calorimeter} + \text{water}}$ )
8. Measure the temperature of the water in the calorimeter ( $T_{\text{initial}}$ )
9. When the water in the beaker boils, use tongs to remove the object and carefully place in the calorimeter
10. Note the maximum temperature of the calorimeter water as it heats up from the object ( $T_{\text{final}}$ )

### Results

$$m_{\text{metal}} = \text{_____ g}$$

$$m_{\text{calorimeter}} = \text{_____ g}$$

$$m_{\text{calorimeter} + \text{water}} = \text{_____ g}$$

#### Temperature increase of the water

$$T_{\text{initial}} = \text{_____ } ^\circ\text{C}$$

$$T_{\text{final}} = \text{_____ } ^\circ\text{C}$$

#### Temperature decrease of the metal

$$T_{\text{initial}} = \text{_____ } ^\circ\text{C}$$

$$T_{\text{final}} = \text{_____ } ^\circ\text{C}$$

### Calculation

1. Find the temperature change of the water ( $\Delta T_{\text{water}}$ ) using  $\Delta T_{\text{water}} = T_{\text{final}} - T_{\text{initial}}$

$$\Delta T_{\text{water}} = \text{_____} - \text{_____}$$

$$\Delta T_{\text{water}} = \underline{\hspace{2cm}} \text{ } ^\circ\text{C}$$

2. Find the temperature change of the metal ( $\Delta T_{\text{metal}}$ ) using  $\Delta T_{\text{metal}} = T_{\text{final}} - T_{\text{initial}}$ . Remember the object started in boiling water at  $100 \text{ } ^\circ\text{C}$ , and cooled to the same  $T_{\text{final}}$  for water

$$\Delta T_{\text{metal}} = \underline{\hspace{2cm}} - \underline{\hspace{2cm}}$$

$$\Delta T_{\text{metal}} = \underline{\hspace{2cm}} \text{ } ^\circ\text{C}$$

3. Mass of the water in the calorimeter

$$m_{\text{water}} = m_{\text{calorimeter+water}} - m_{\text{calorimeter}}$$

$$m_{\text{water}} = \underline{\hspace{2cm}} \text{ g} - \underline{\hspace{2cm}} \text{ g}$$

$$m_{\text{water}} = \underline{\hspace{2cm}} \text{ g}$$

4. Calculating the energy absorbed by the water ( $q_{\text{water}}$ ) from the cooling metal object using  $q = mc\Delta T$

$$q_{\text{water}} = m_{\text{water}} \times c_{\text{water}} \times \Delta T_{\text{water}} \quad \text{and} \quad (c_{\text{water}} = 4.184 \text{ J/g}^\circ\text{C})$$

$$q_{\text{water}} = \underline{\hspace{2cm}} \text{ g} \times \underline{\hspace{2cm}} \text{ J/g}^\circ\text{C} \times \underline{\hspace{2cm}} \text{ } ^\circ\text{C}$$

$$q_{\text{water}} = \underline{\hspace{2cm}} \text{ J}$$

5. The energy lost by the metal is absorbed by the water and calorimeter:

$$-q_{\text{metal}} = q_{\text{water}} + q_{\text{calorimeter}}$$

But  $q_{\text{calorimeter}}$  is negligible (i.e. 0) because it is a light, well insulated cup

$$\text{So: } -q_{\text{metal}} = q_{\text{water}} + 0$$

$$\text{Or: } q_{\text{metal}} = -q_{\text{water}}$$

$$\text{So: } q_{\text{metal}} = - \underline{\hspace{2cm}} \text{ J} \quad (\text{substituting } q_{\text{water}} \text{ from step 4)}$$

6. To find out what  $c_{\text{metal}}$  is using  $q = mc\Delta T$  we need to rearrange the formula so it reads  $c_{\text{metal}} = \dots$

- Divide both sides of  $q = mc\Delta T$  by  $m\Delta T$
- Cancel the  $(m\Delta T) / (m\Delta T)$  on the right hand side to leave  $c$

$$c = \frac{q_{\text{metal}}}{m_{\text{metal}} \Delta T_{\text{metal}}}$$

Now use the value you calculated for  $q_{\text{metal}}$  and  $\Delta T_{\text{metal}}$  and the value you measured for  $m_{\text{metal}}$  from your results in the above formula:

$$c = \frac{(\quad)}{(\quad) \times (\quad)} \text{ J/g}^\circ\text{C}$$

Calculate the answer:

$$c = \text{_____ J/g}^\circ\text{C}$$

Finally, round to the same number of figures as the measurement with the least number of significant figures

$$c = \text{_____ J/g}^\circ\text{C}$$

### Conclusion

The Specific heat capacity of the metal object was \_\_\_\_\_ J/g<sup>o</sup>C