Name ________________________________

nJoy

Experiment 12.2 Calorimetry

Hypothesis We can use what we know about water to measure the specific heat capacity of a metal object

Procedure

1. Heat ¼ of a mug of water on a burner.
2. Weigh the hex nut (m_{metal}) to the nearest gram.
3. Place the hex nut in the water on the burner.
4. Place one Styrofoam cup within another to make a calorimeter.
5. Weigh the empty calorimeter ($m_{calorimeter}$).
6. Add enough cold water to the calorimeter so when you add the hex nut later it will be fully submerged.
7. Weigh the calorimeter with the water ($m_{calorimeter + water}$).
8. Measure the temperature of the water in the calorimeter to the tenth of a degree ($T_{initial}$).
9. When the water in the mug boils, use tongs to remove the hex nut and carefully place in the calorimeter
10. Note the maximum temperature (T_{final}) to the tenth of a degree of the calorimeter water as it heats up from the hex nut.

Observations

m_{metal} = ________ g (mass of the hex nut)

$m_{calorimeter}$ = ________ g (mass of the empty cups)

$m_{calorimeter + water}$ = ________ g (mass of the cups and cold water)

Temperature increase of the water

$T_{initial}$ = _______ °C (temperature of the cold water to begin with)

T_{final} = _______ °C (temperature of the cold water after the hex nut was added)

Temperature decrease of the metal

$T_{initial}$ = _______ °C (temperature of the hex nut in boiling water)

T_{final} = _______ °C (temperature of the hex nut after it has cooled down in the water)

Calculation

1. How much warmer did the water in the calorimeter become?
Find the temperature change of the water (ΔT_{Water}) using $\Delta T_{water} = T_{final} - T_{initial}$

ΔT_{water} = _______ °C - _________°C

ΔT_{water} = _______ °C

2. How much colder did the hex nut become?
Find the temperature change of the metal (ΔT_{metal}) using $\Delta T_{metal} = T_{final} - T_{initial}$. Remember, the object **started** in boiling water at 100 °C, and cooled to the same T_{final} for water.

ΔT_{metal} = _______ °C - _________°C

ΔT_{metal} = _______ °C

3. What is the mass of the water in the calorimeter (two cups)?
$m_{water} = m_{calorimeter+water} - m_{calorimeter}$

m_{water} = ________ g - ________ g

m_{water} = _________ g

4. How much energy did the water absorb from the heated hex nut?
Calculate the energy absorbed by the water (q_{water}) from the cooling metal object using $q = mc\Delta T$

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

q_{water} = ______ g x ____________ J/g°C x ________ °C
(use the numbers you've calculated in the previous steps for m_{water} and ΔT_{water})

q_{water} = _____________ J

5. How much energy did the hex nut release into the water and the calorimeter? You can calculate that with this formula, $-q_{metal} = q_{water} + q_{calorimeter}$
because the energy **lost** by the metal is **absorbed** by the water and calorimeter. Furthermore, since the calorimeter is a light, well insulated cup, the energy it absorbed ($q_{calorimeter}$) is negligible (i.e. 0), so the energy the water absorbed is the same amount as the hex nut released or **lost.**

So: $q_{calorimeter} = 0$,

therefore, $-q_{metal} = q_{water} + 0$

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

Therefore: q_{metal} = – ______________ J (substituting q_{water} from step 4)

6. So, what is the specific heat capacity of the hex nut (c_{metal})?
   To find out what the specific heat capacity (c_{metal}) is, use $q = mc\Delta T$, and rearrange the formula so it reads c_{metal} = …

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

   $$c_{metal} = \frac{q_{metal}}{m_{metal}\Delta T_{metal}}$$

   Now insert into this formula the values you calculated for q_{metal} (the energy **lost** by the hex nut) and ΔT_{metal}, and your measurement of m_{metal}:

   $$c_{metal} = \frac{(\qquad\qquad\qquad J)}{(\qquad\qquad g)(\qquad\qquad °C)}$$

   Calculate the answer:

   c_{metal} = _______________ J/g°C

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

   c_{metal} = _______________ J/g°C

   (The least precise measurement is the temperature change of the water, which is usually 1 significant figure.)

Conclusion

The Specific heat capacity of the hex nut was ___________ J/g°C