**Thermodynamics worksheet**

**N**ame: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Period: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Design Need:** The customer needs a thermos designed that is capable of the following:

* holding 200mL of water
* spending less than $3 for all materials
* least amount of heat loss (smallest decrease in temperature of boiling water after 10 minutes)
* lowest total design cost
* using only the materials listed below
* **Can be built & tested by end of class tomorrow (2 days total)**

**Material Specifications: Heat Loss Equation:**

|  |  |  |
| --- | --- | --- |
| **Material** | **Thermal Conductivity****(W/m.K)** | **Cost****($)** |
| Water (insulation) | 0.60 | 0.25/ mL |
| Aluminum Foil | 250 | 0.05/ inch |
| Cotton Balls | 0.03 | 0.15/ each |
| Paper Cup | 0.05 | 0.55/ each |
| Sand | 0.25 | 0.01/ gram |
| Plastic Cup | 0.23 | 0.15/ each |
| Styrofoam Cup | 0.03 | 0.85/ each |
| Paint | *radiation heat*  | 0.25/ layer |
| Foam Insulation | 0.03 | 0.05/ inch |
| Masking Tape | 0.08 | 0.05/ inch |

Fourier’s Law: **

 where

**q** = heat transferred per unit time (W)

**A** = heat transfer area (m2)

**k** = thermal conductivity of the material (W/m.K)

**TH** = hot temperature (K)

**TC** = cold temperature (K)

**L** = material thickness (m)

**1. Complete the following statements based on the introduction from your teacher**

 a. According to the Heat Loss Equation the value of **q** should be \_\_\_\_\_\_\_\_ (big or small) if we want

 less heat loss.

 b. According to the Heat Loss Equation the value of **q** should be \_\_\_\_\_\_\_\_ (big or small) if we want

 more heat loss.

 c. According to the Heat Loss Equation the value of **k** should be \_\_\_\_\_\_\_\_ (big or small) if we want

 less heat loss.

 d. According to the Heat Loss Equation the value of **k** should be \_\_\_\_\_\_\_\_ (big or small) if we want

 more heat loss.

**2. Draw a picture of Design #1. Include cost of design and construction details.**

Fill in the following table as you choose materials.

|  |  |  |
| --- | --- | --- |
| **Material** | **Quantity** | **Cost** **($)** |
|  |  |  |
|  |  |  |
|  |  |  |
|   |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

Complete the following table as you test your design

|  |  |
| --- | --- |
| **Time (minutes)** | **Temperature (oF)** |
| 0 - initial temperature reading |  |
| 1 |  |
| 2 |  |
| 3 |  |
| 4 |  |
| 5 |  |
| 6 |  |
| 7 |  |
| 8 |  |
| 9 |  |
| 10 |  |

**3. Draw a picture of Design #1. Include cost of design and construction details**

Fill in the following table as you choose materials.

|  |  |  |
| --- | --- | --- |
| **Material** | **Quantity** | **Cost** **($)** |
|  |  |  |
|  |  |  |
|  |  |  |
|   |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

Complete the following table as you test your design

|  |  |
| --- | --- |
| **Time (minutes)** | **Temperature (oF)** |
| 0 - initial temperature reading |  |
| 1 |  |
| 2 |  |
| 3 |  |
| 4 |  |
| 5 |  |
| 6 |  |
| 7 |  |
| 8 |  |
| 9 |  |
| 10 |  |

**4. Plot the heat loss of each thermos design**

 **- y-axis = temperature**

 **- x-axis = time in minutes**



**5. What was your best design (#1 or #2)?**

DESIGN COST = $

T (TEMPERATURE LOSS) = oF after 10 minutes

$/T =

**Be ready to present your design to the class.**