Thermodynamics worksheet

Name: _____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:

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

Heat Loss Equation:

Fourier's Law: $q = \dfrac{k \cdot A \cdot (T_H - T_C)}{L}$

where

q = heat transferred per unit time (W)

A = heat transfer area (m^2)

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

T_H = hot temperature (K)

T_C = 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 <u>Heat Loss Equation</u> 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 (^{o}F)
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 ($^{\circ}$F)
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

(axis label)

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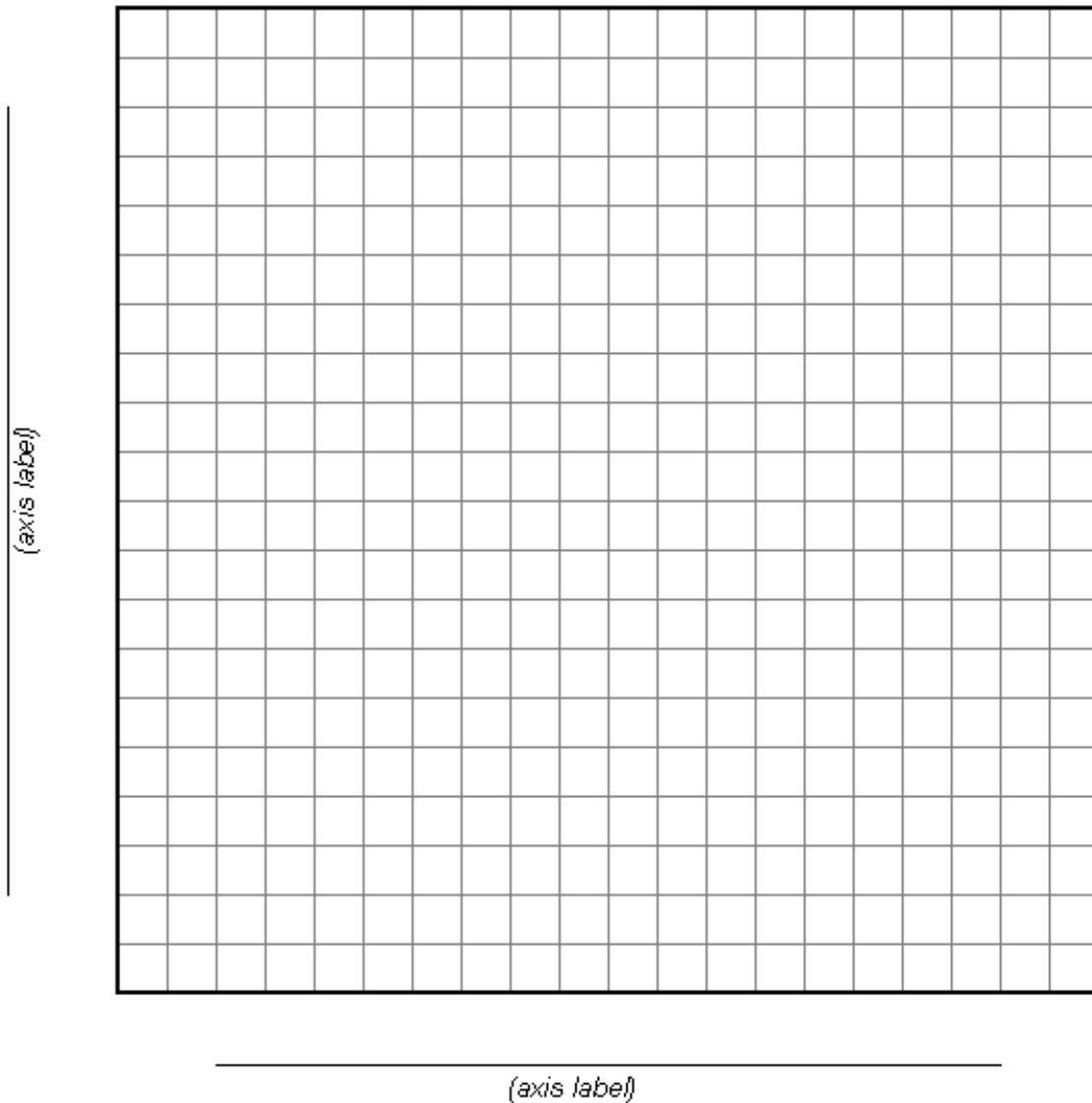
5. What was your best design (#1 or #2)?

DESIGN COST = $ _____

ΔT (TEMPERATURE LOSS) = _____ °F after 10 minutes

$/ΔT = _____

Be ready to present your design to the class.