Heat Transfer

Name________________________________ ID________________________ TA________________

Partners____

Date______________________________________ Section____________________________________

Exercise caution when you deal with the hot water.

1. **Surface color dependence**
   - *Take hot water 1/3 of the both containers. Spend about 10 minutes.*

Heat transfer constant, k, for a white can ________________________________(1/s)

Heat transfer constant, k, for a black can ________________________________(1/s)

* When the temperature goes down faster, is the constant, k, smaller or larger?

* Do the above results make sense? Explain the reason for your answer.

2. **External environment dependence**
   - *Take a black-colored can, and use a light to shine it for 10 minutes. (hot water 1/3 of the containers)*

Heat transfer constant, k, for a black can shined by a light ______________________(1/s)

   - *Take a black-colored can, and use a fan to increase air circulation for 10 minutes. (hot water 1/3 of the containers)*

Heat transfer constant, k, for a black can with a fan ___________________________(1/s)

* Which one has the larger or smaller constant? Explain why it should be.

3. **Water quantity dependence**
   - *Take the white and chrome ones with water 1/3 of and 2/3 of the cans respectively. (10min.)*

Heat transfer constant, k, for the white can with a small amount of water
____________________(1/s)

Heat transfer constant, k, for the silver can with a large amount of water
____________________(1/s)

* Which one has the larger or smaller constant? Explain why it should be.

Please discuss the above questions in your report, and do not forget to attach the graphs with the line equations.

Lab Procedure for Heat Transfer

The procedure for this lab is quite straightforward. By following the instructions, you will take the hot water and measure the temperatures. For each part, you will answer the questions to test your understanding.

- **How to analyze the acquired data**

1. Obtain the room temperature.
   Use a thermometer. If it is in Fahrenheit, convert it into Celsius by calculating $^{o}C = \frac{5}{9}\left(^{o}F - 32\right)$. You will assume that the room temperature is constant through the lab.

2. Measure the change of temperatures of the hot water with Science Workshop (DataStudio).
   Every 30 seconds, you will record the temperature. To change the setting in Science Workshop, go to 'Experiment', select 'Sampling Options.' Then change the 'Periodic Samples' into 30 sec.

3. Copy and paste the data on Excel spread sheet from Science Workshop (DataStudio).
   The time, t, and temperature, T, are from the acquired data. The time should be from 0 to 10. ⇒

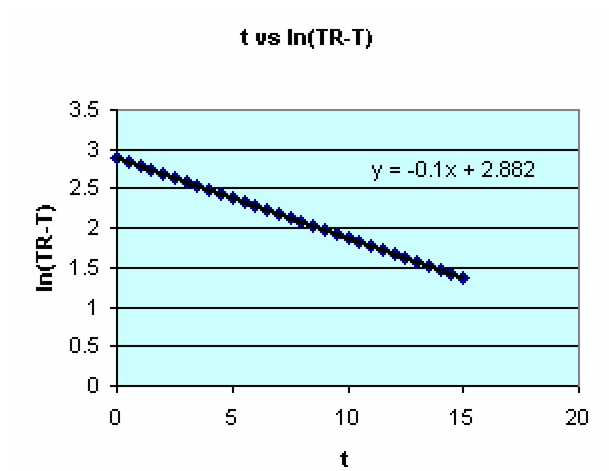
Microsoft Excel - Hand out for Heat

	A	B	C
1	Room Temp.	from Sci. Work Shop	
2	TR	t	T
3	20	0	37.85041
4		0.5	36.97984
5		1	36.15172
6		1.5	35.36399
7		2	34.61468
8		2.5	33.90192
9		3	33.22391
10		3.5	32.57897
11		4	31.96549
12		4.5	31.38193
13		5	30.82682
14		5.5	30.29879
15		6	29.79651
16		6.5	29.31873
17		7	28.86425
18		7.5	28.43194
19		8	28.02071

4. ⇐ Calculate ln(T_R-T) using Excel.
   The temperature is function of time as $T(t) = T_R + (T_0 - T_R)e^{-kt}$ where T_0 is the initial temperature. The temperature is exponential decay with the decay rate, k. Take logarithm of both sides, you have $\ln(T(t) - T_R) = -kt + \ln(T_0 - T_R)$. The second term in RHS is a constant. If you plot t vs. $\ln(T(t) - T_R)$, you will get a linear line. The slope without the negative sign is the heat transfer constant, k.

	A	B	C	D
1	Room Temp.	from Sci. Work Shop		
2	TR	t	T	ln(T-TR)
3	20	0	37.85041	2.882027
4		0.5	36.97984	2.832027
5		1	36.15172	2.782027
6		1.5	35.36399	2.732027
7		2	34.61468	2.682027
8		2.5	33.90192	2.632027
9		3	33.22391	2.582027
10		3.5	32.57897	2.532027
11		4	31.96549	2.482027
12		4.5	31.38193	2.432027
13		5	30.82682	2.382027
14		5.5	30.29879	2.332027
15		6	29.79651	2.282027
16		6.5	29.31873	2.232027
17		7	28.86425	2.182027
18		7.5	28.43194	2.132027

5. Plot ln(T-T_R) vs. t as shown.
   You also have to obtain the line equation. In this example, $k = 0.1$.



6. Repeat the procedure for the other cases.