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2021-2022 Quality Education Fund Thematic Network – Tertiary Institutes
STEM Project Team

SCHOOL: CHRISTIAN AND MISSIONARY ALLIANCE SUN KEI SECONDARY SCHOOL (S4)

TOPIC: DESIGN OF PORTABLE SELF-HEATING LUNCH BOX

科學與環境學系
Department of Science and Environmental Studies

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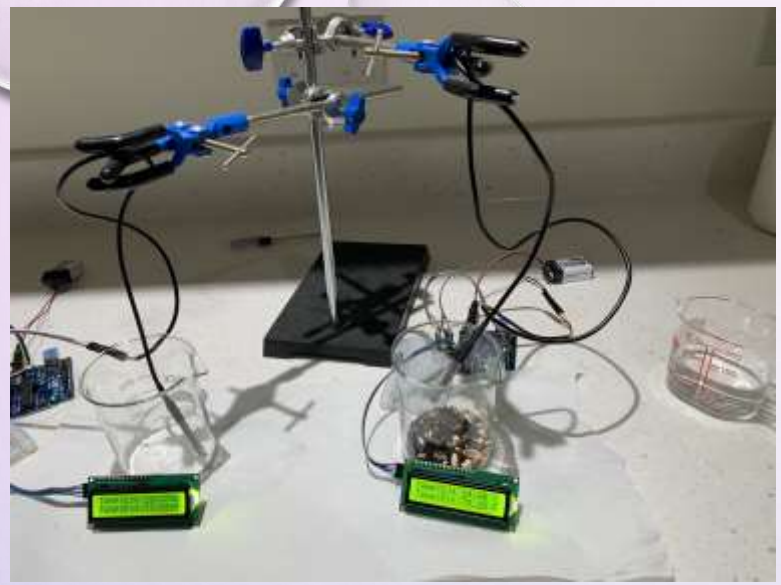
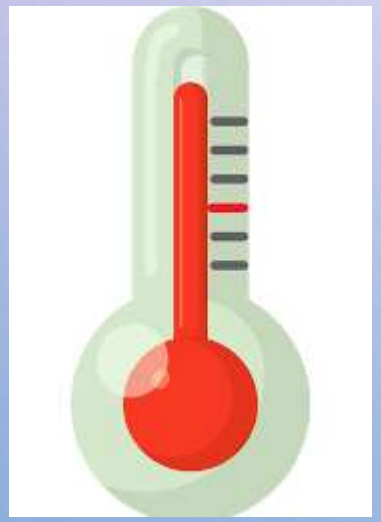


SELF-HEATING LUNCH BOX



(1) METHODS FOR HEATING

(2) THERMAL INSULATION/HEAT CONDUCTION MATERIAL

(3) TEMPERATURE SENSOR - DS18B20

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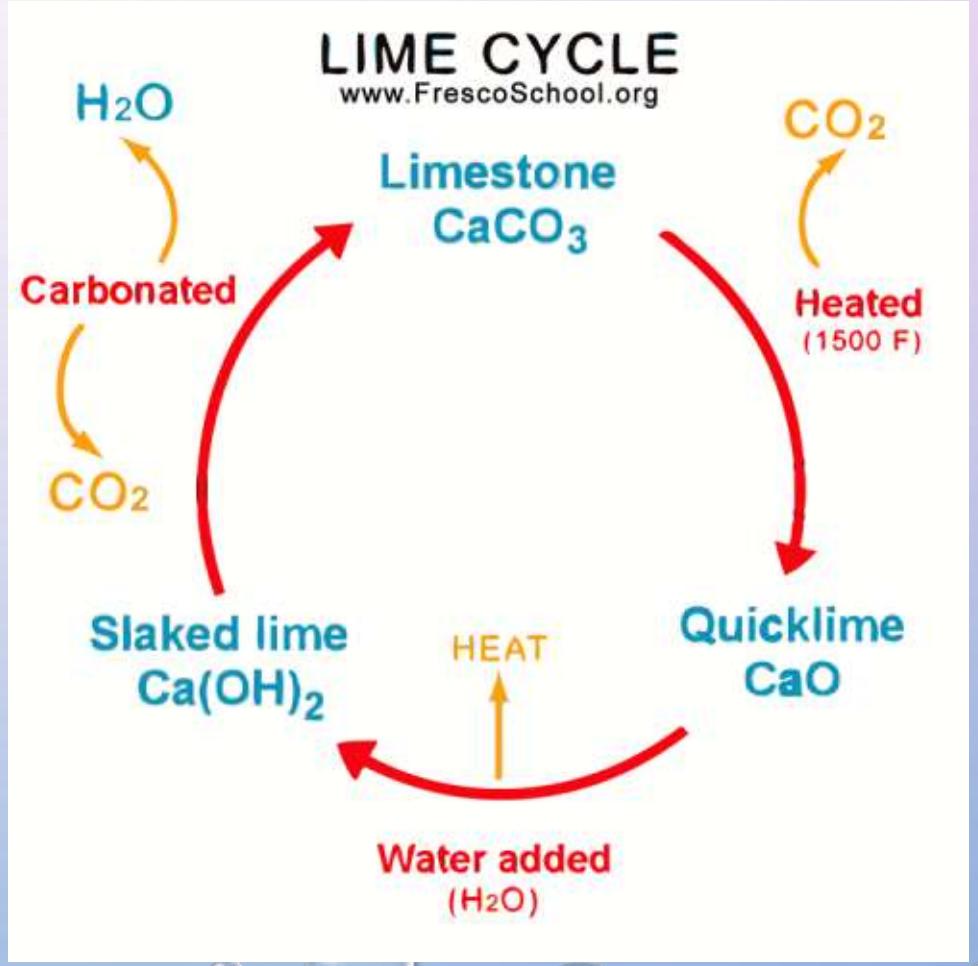
1.1 LIME CYCLE

- CAO(S) + H2O (L) → $CA(OH)_2$(S) + **HEAT**



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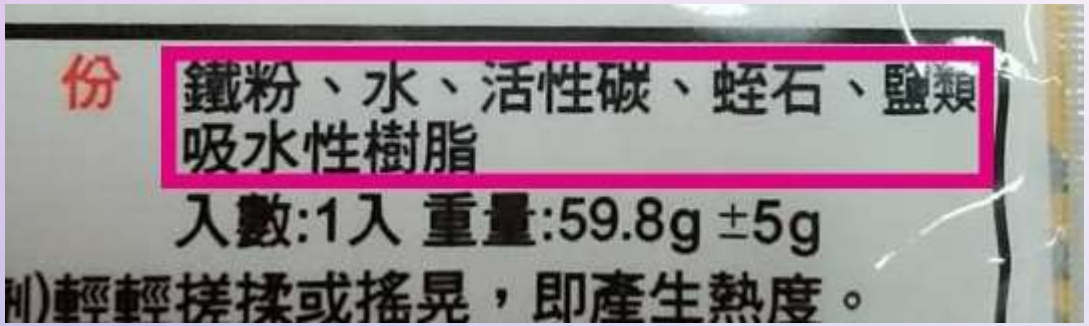
1.2 WARMER (暖包)



暖包的成份有鐵粉、水、活性碳、蛭石和鹽。

科學原理：
暖包是利用鐵的氧化反應，放出熱能，使我們感受到暖。

以下是化學反應方程式：
鐵 + 水 + 氧氣 → 水合氧化鐵 + 熱

活性碳和鹽是催化劑，加速氧化反應；蛭石是絕緣材料，將熱力維持一段長時間。

- 活性碳和鹽：催化劑
- 蛭石：保暖

Material	Component Ratio
Activated carbon (活性碳)	4
Water	1(Depends on the size of the carbon particles, <1)
Iron Filings (鐵粉)	1
Lernilite (Vermiculite) (蛭石)	1
Salt	1

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SCIENTIFIC PRINCIPLE: THE CHEMICAL REACTION OF RUST

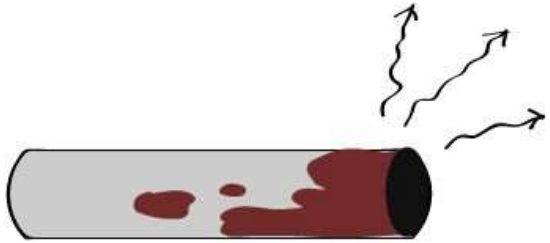
(1) $Fe_{(s)} \rightarrow Fe^{2+}_{(aq)} + 2e^-$

(2) $O_{2(g)} + 2H_2O_{(l)} + 4e^- \rightarrow 4OH^-_{(aq)}$

(3) $Fe^{2+}_{(aq)} + 2OH^-_{(aq)} \rightarrow Fe(OH)_{2(s)}$

(4) $4Fe(OH)_{2(s)} + O_{2(g)} \rightarrow 2Fe_2O_3 \cdot H_2O_{(s)} + 2H_2O_{(l)}$

Exothermic



ΔH = -1625 kJ
exothermic heat
(gives up heat)

$4Fe(s) + 3O_2(g) \longrightarrow 2Fe_2O_3(s)$

Ferrous (iron) Oxygen Ferrous Oxide (known as rust)

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PROCEDURE

1

Size

2

Catalyst (催化劑)

3

Heat Preservation

4

Start counting

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TIPS: MIX(POWDER)

Design a Package?
Or even a double package?

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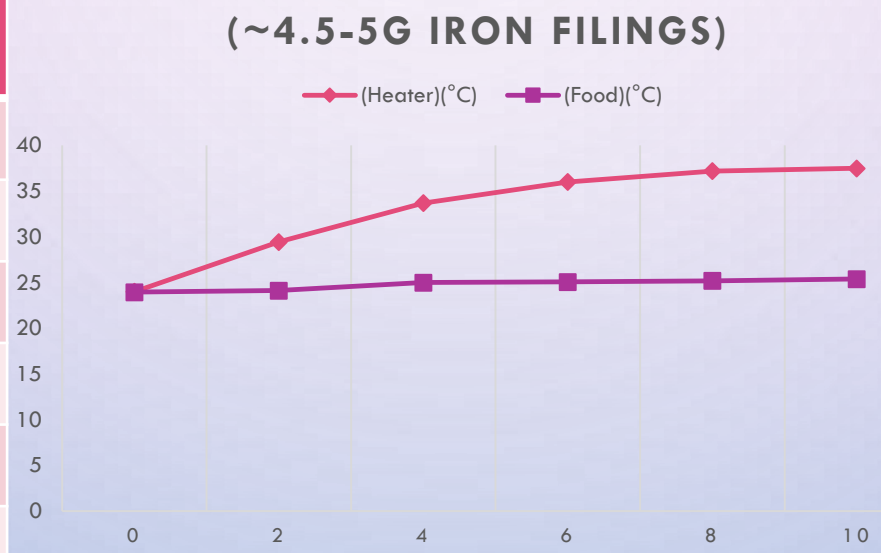
TEST01
(~4.5-5G IRON FILINGS)

Time (mins)	Temperature (Heater)(°C)	Temperature (Food)(°C)
0	24.00	23.94
2	29.44	24.11
4	33.69	25.00
6	36.00	25.06
8	37.19	25.19
10	37.50	25.37



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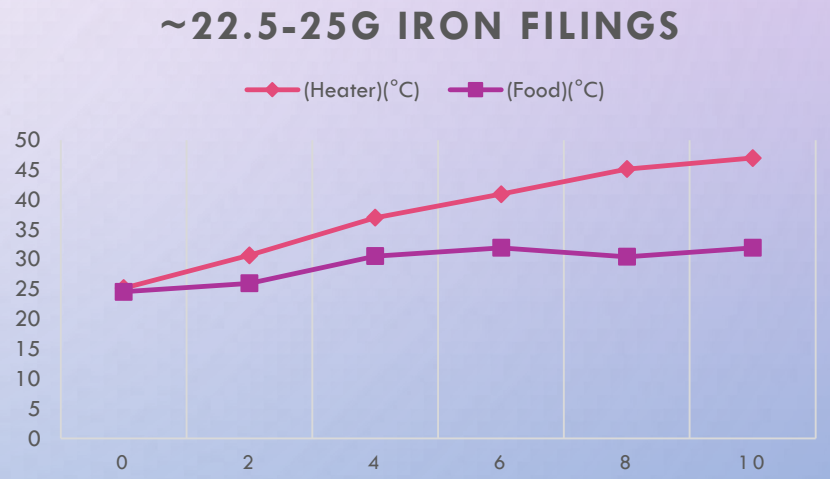
TEST02
(~22.5-25G IRON FILINGS)

Time (mins)	Temperature (Heater)(°C)	Temperature (Food)(°C)
0	25.19	24.56
2	30.69	26.00
4	37.00	30.56
6	40.94	31.94
8	45.13	30.44
10	47.00	31.94



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EXTENDED ACTIVITIES

1

- 活性碳和鹽：催化劑
- 蛭石：保暖

1	鐵	活性碳	鹽	水	蛭石
	O	O	O	O	O

時間(分)	0	2	4	6	8	10
溫度(℃)	21	24	30	35	38	40

2	鐵	活性碳	鹽	水	蛭石
	X	O	O	O	O

時間(分)	0	2	4	6	8	10
溫度(℃)	22	22	22	22	22	22

3	鐵	活性碳	鹽	水	蛭石
	O	X	O	O	O

時間(分)	0	2	4	6	8	10
溫度(℃)	21	21	21	21	21	21

4	鐵	活性碳	鹽	水	蛭石
	O	O	X	O	O

時間(分)	0	2	4	6	8	10
溫度(℃)	22	25	29	32	34	34

5	鐵	活性碳	鹽	水	蛭石
	O	O	O	X	O

時間(分)	0	2	4	6	8	10
溫度(℃)	21	21	21	21	21	21

6	鐵	活性碳	鹽	水	蛭石
	O	O	O	O	X

時間(分)	0	2	4	6	8	10
溫度(℃)	21	25	31	36	34	34

7	鐵	活性碳	鹽	水	蛭石
	X	X	X	X	X

時間(分)	0	2	4	6	8	10
溫度(℃)	21	21	21	21	21	21

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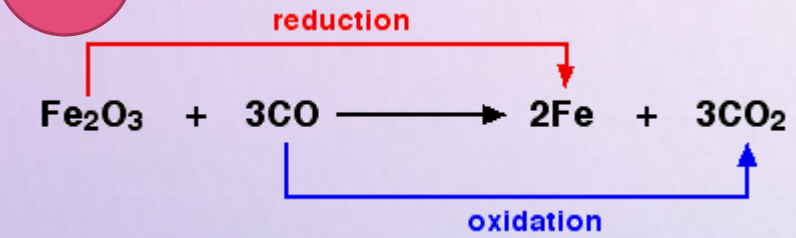
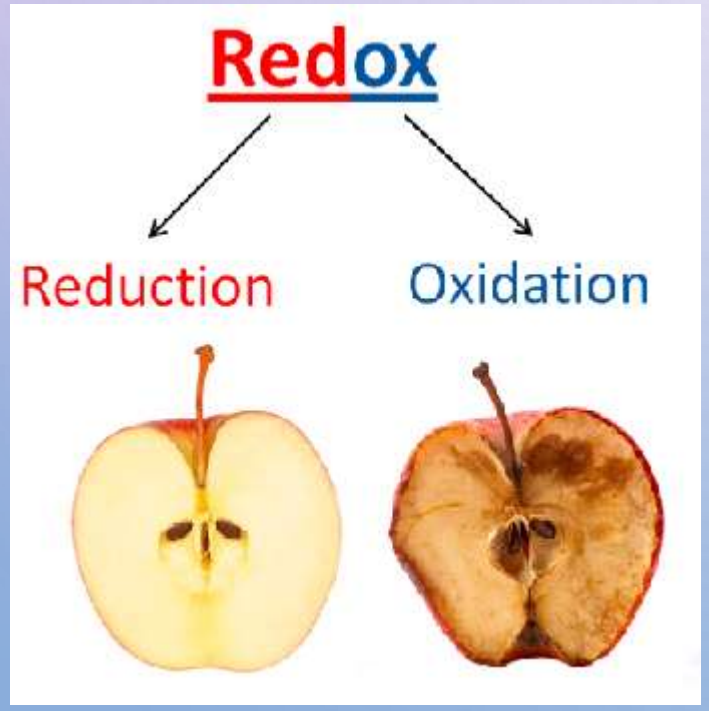
EXTENDED ACTIVITIES

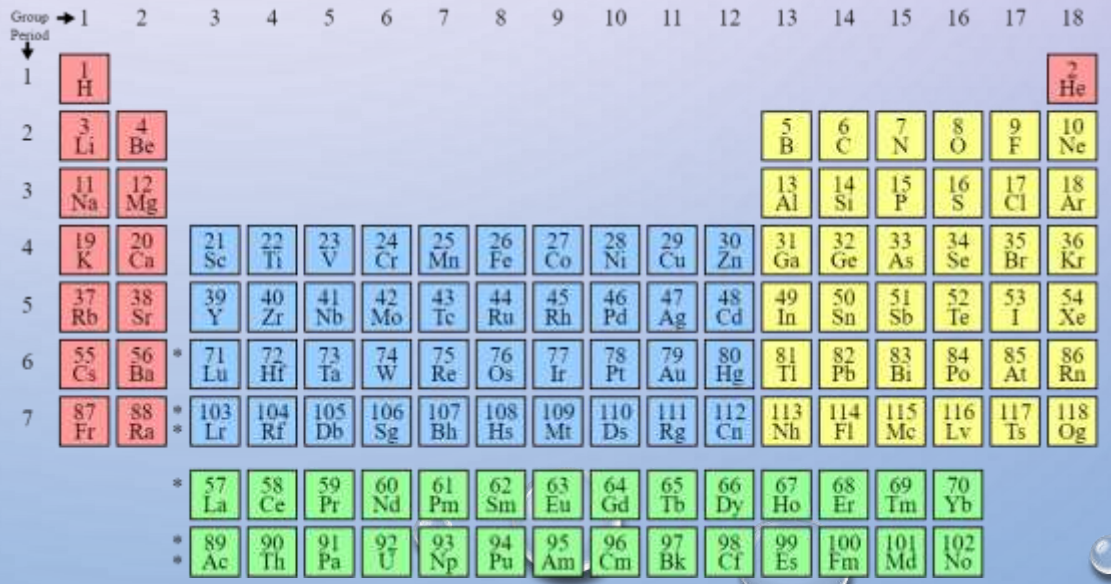
2





3

Trying other metals, recommended: magnesium (Mg), zinc(Zn) and aluminum(Ai) instead of iron to do the same experiment to compare the heating effect of iron oxidation.



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2
THERMAL INSULATION/HEAT CONDUCTION MATERIAL

Good/poor heat conductor

Good/poor heat conductor

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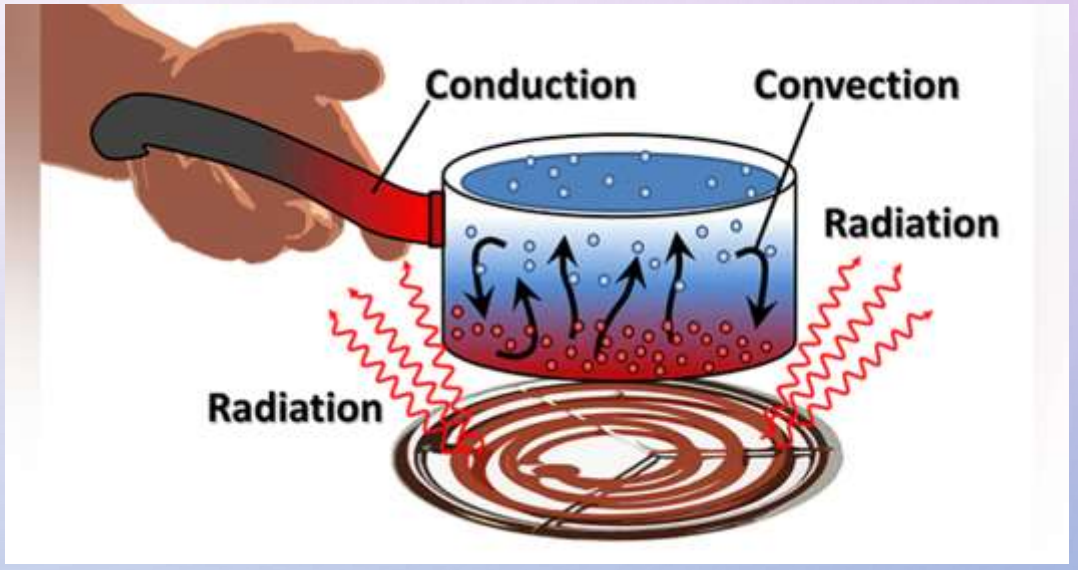
(2.1) GOOD/POOR HEAT CONDUCTOR
(2.2) HEAT TRANSFER



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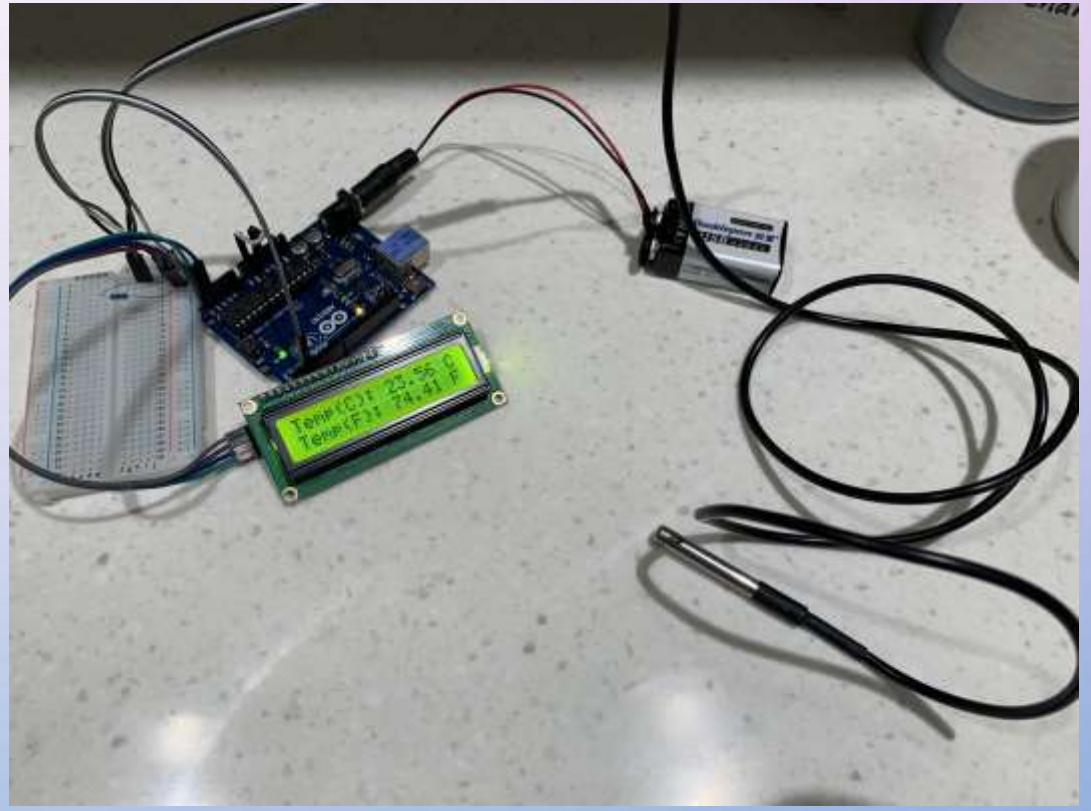
3
TEMPERATURE SENSOR - DS18B20



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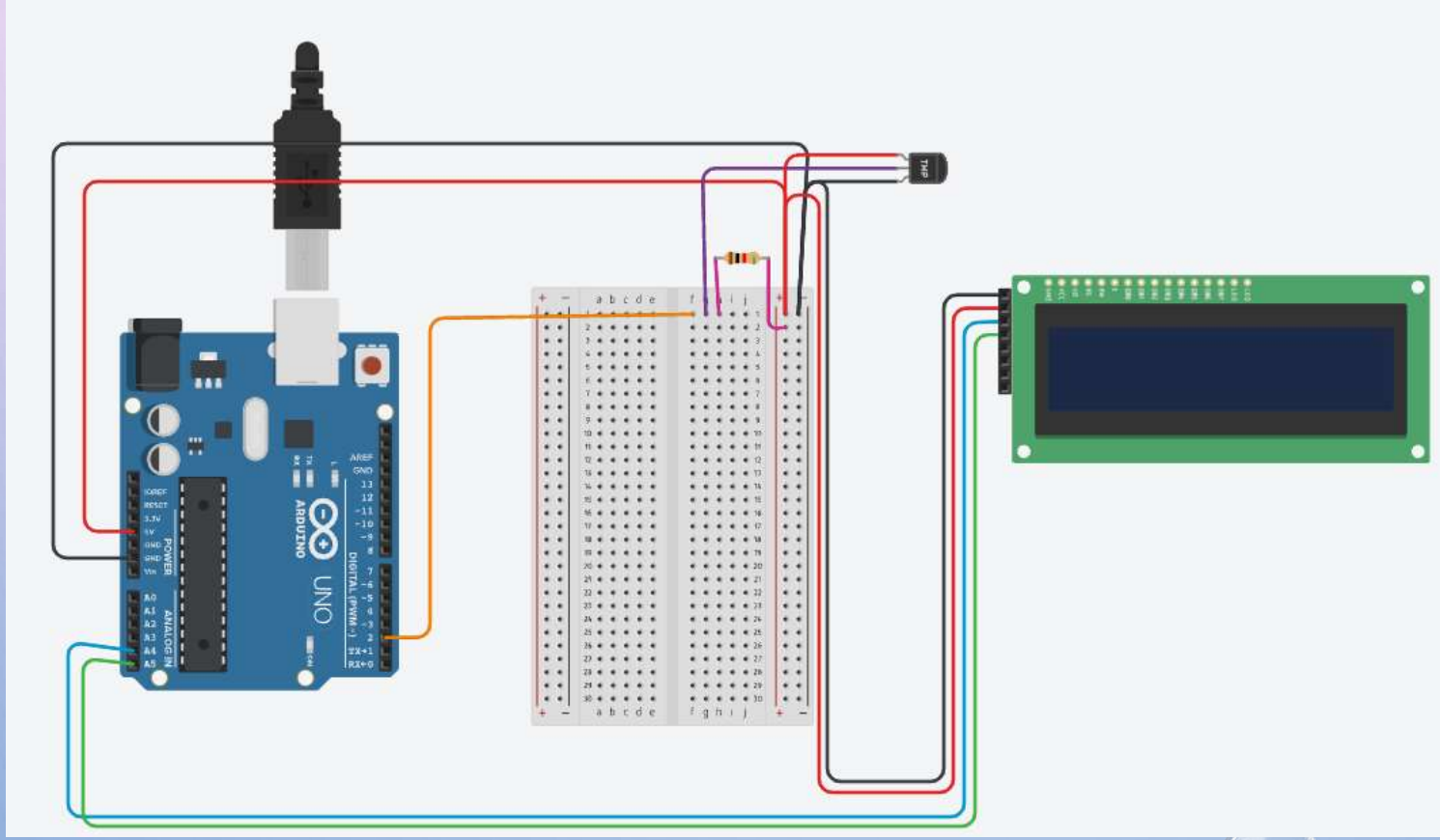
CIRCUIT



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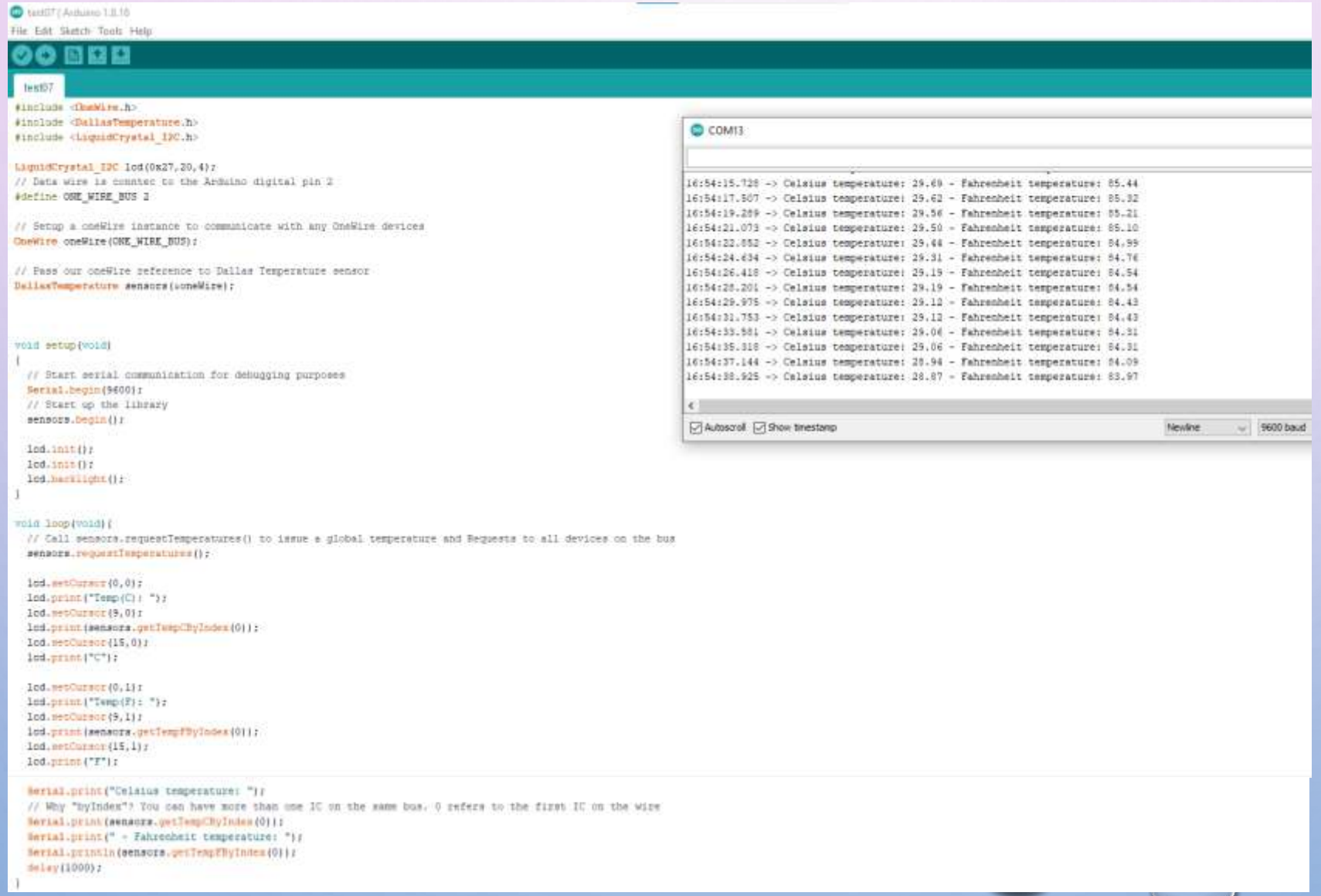
CODING



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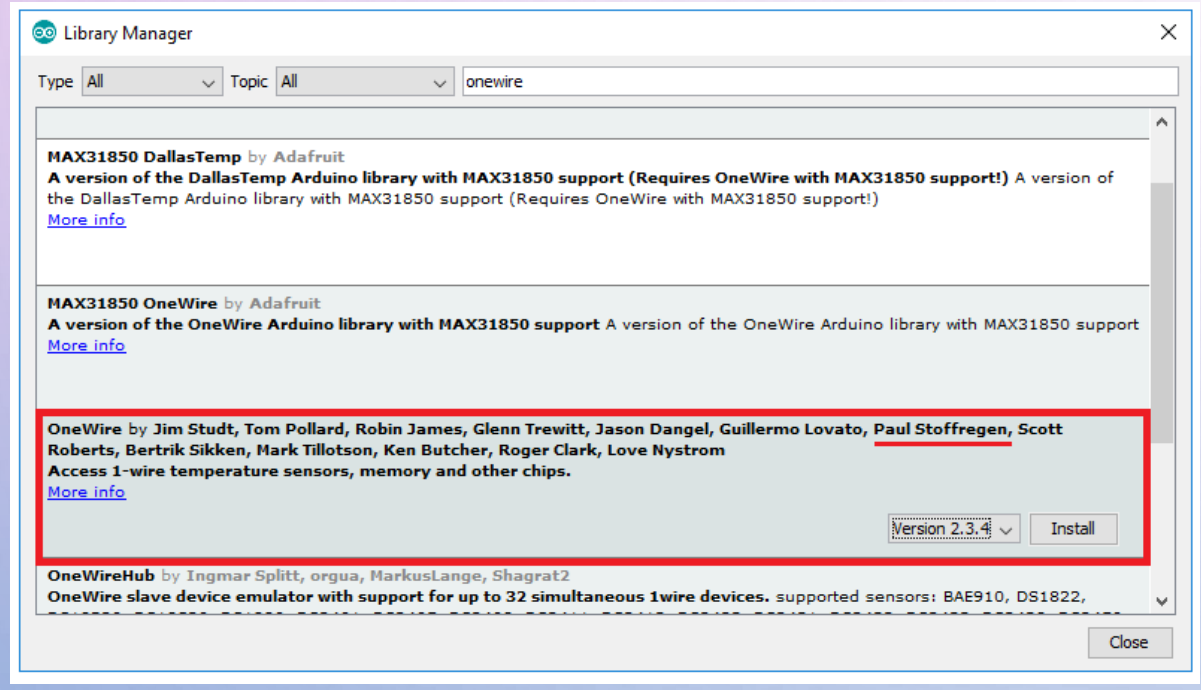
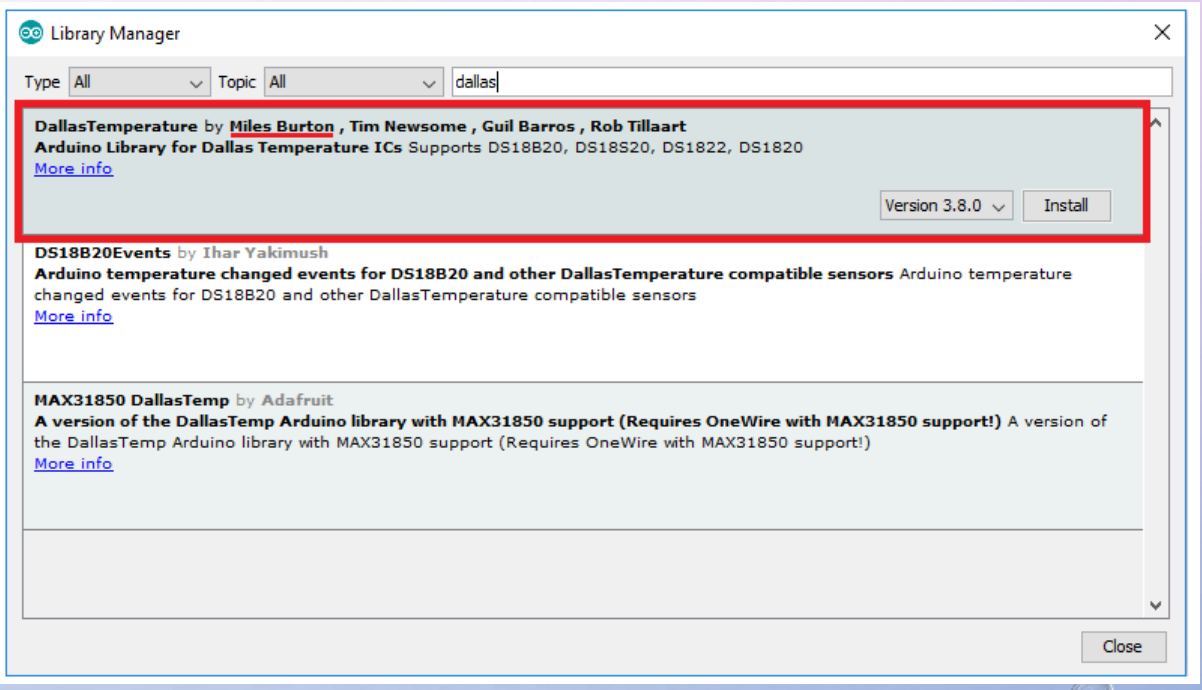
INSTALLING LIBRARIES





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EMERGING DESIGN COMPARISON