

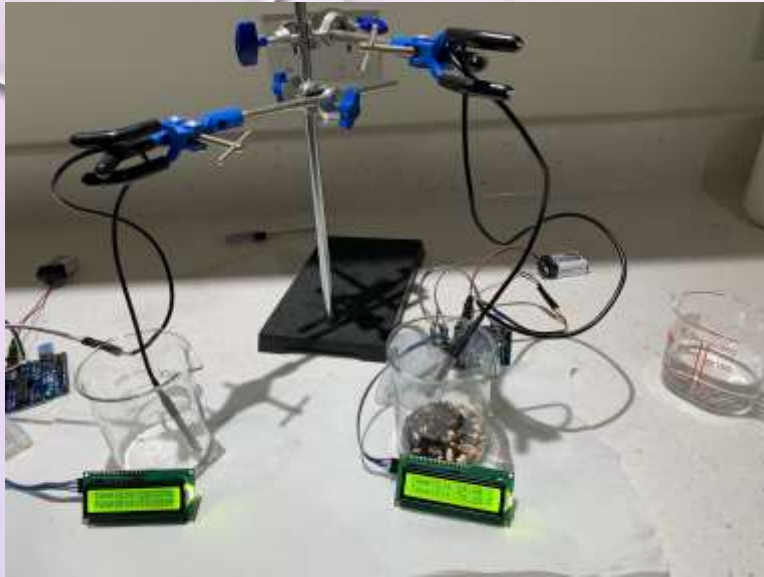
The Education University of Hong Kong

2021-2022 Quality Education Fund Thematic Network – Tertiary Institutes

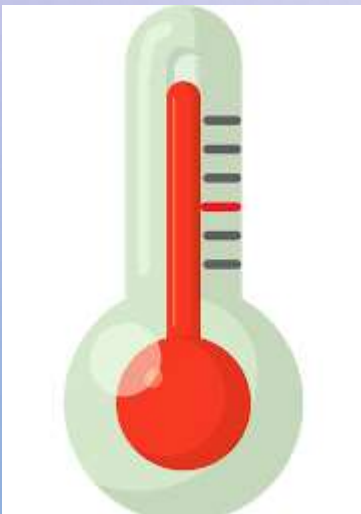
STEM Project Team

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

TOPIC: DESIGN OF PORTABLE SELF-HEATING LUNCH
BOX



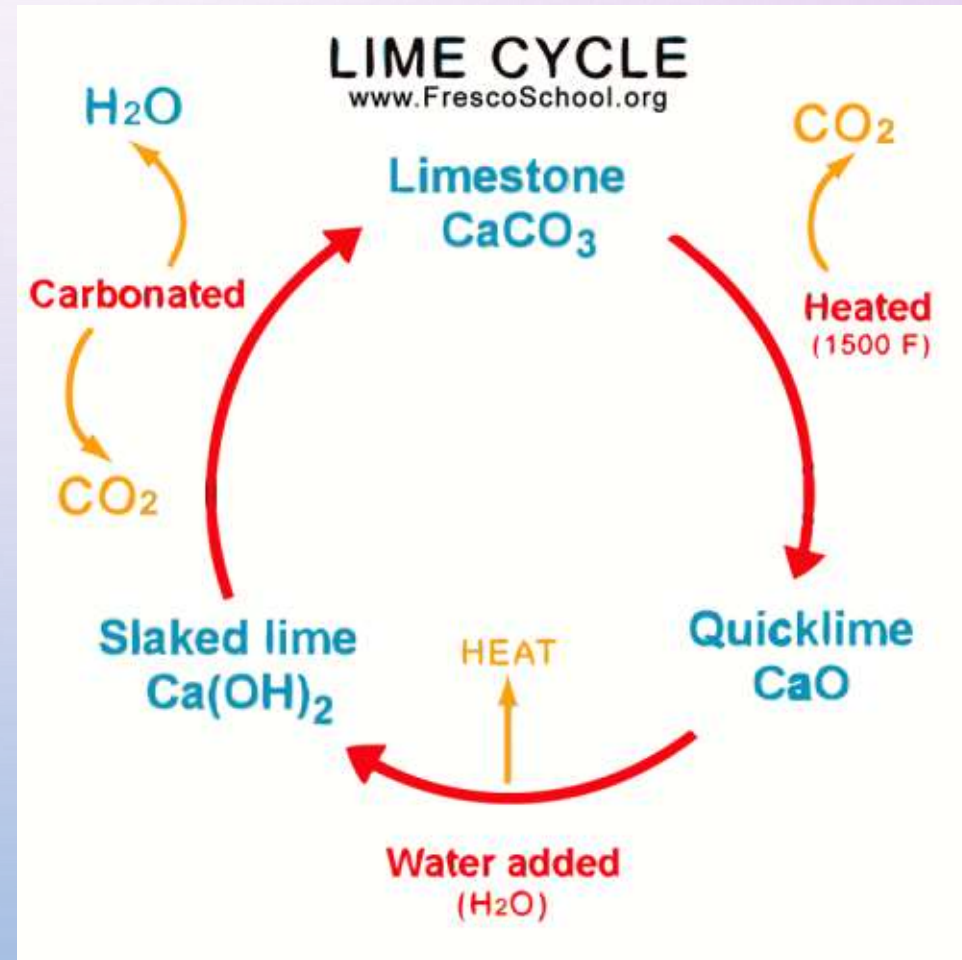
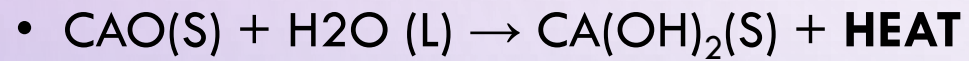
SELF-HEATING LUNCH BOX



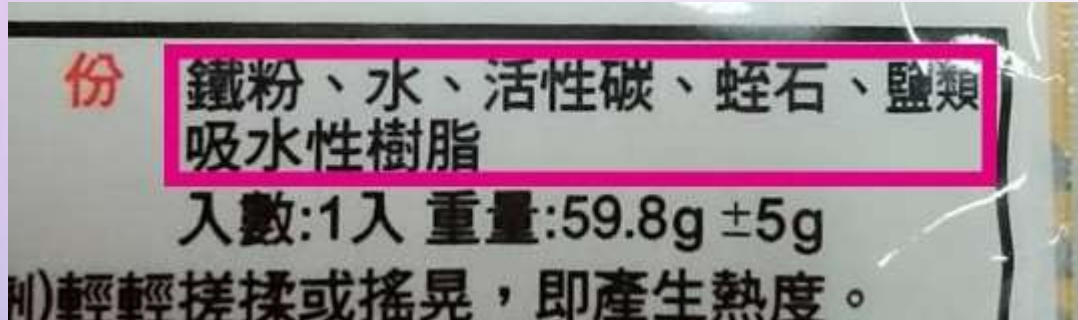
- (1) METHODS FOR HEATING
- (2) THERMAL INSULATION/HEAT CONDUCTION MATERIAL
- (3) TEMPERATURE SENSOR - DS18B20



1.1 LIME CYCLE



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：

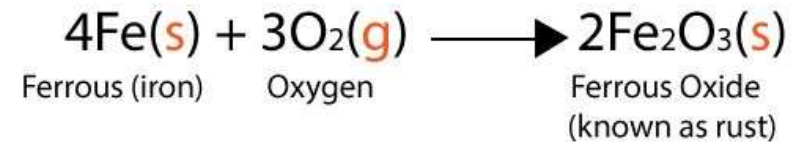
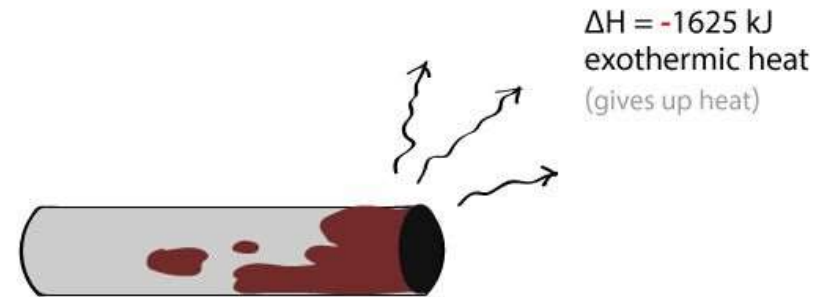
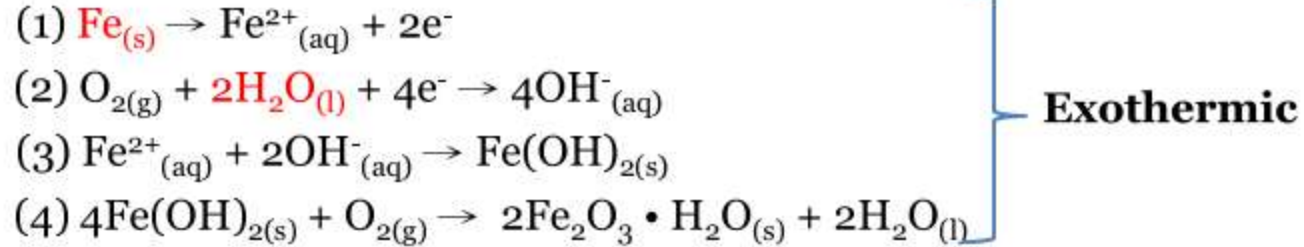
鐵 + 水 + 氧氣 → 水合氧化鐵 + 熱

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

SCIENTIFIC PRINCIPLE: THE CHEMICAL REACTION OF RUST



PROCEDURE



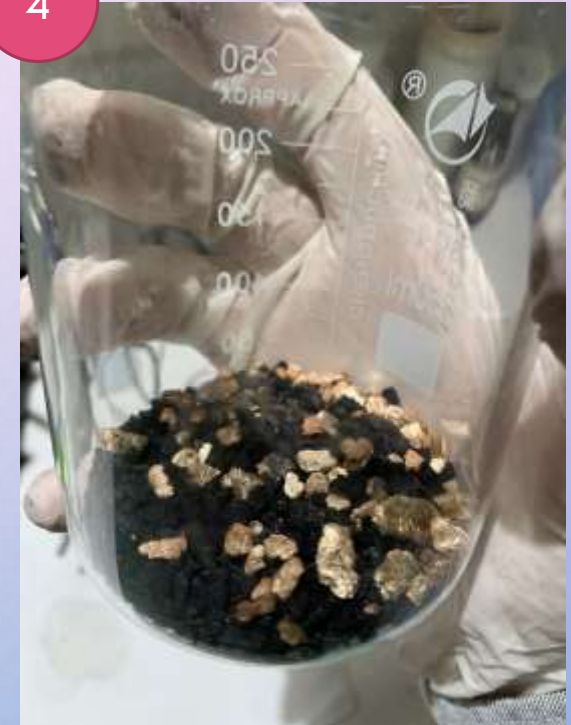
Size



Catalyst (催化劑)



Heat Preservation



Start counting

TIPS: MIX(POWDER)



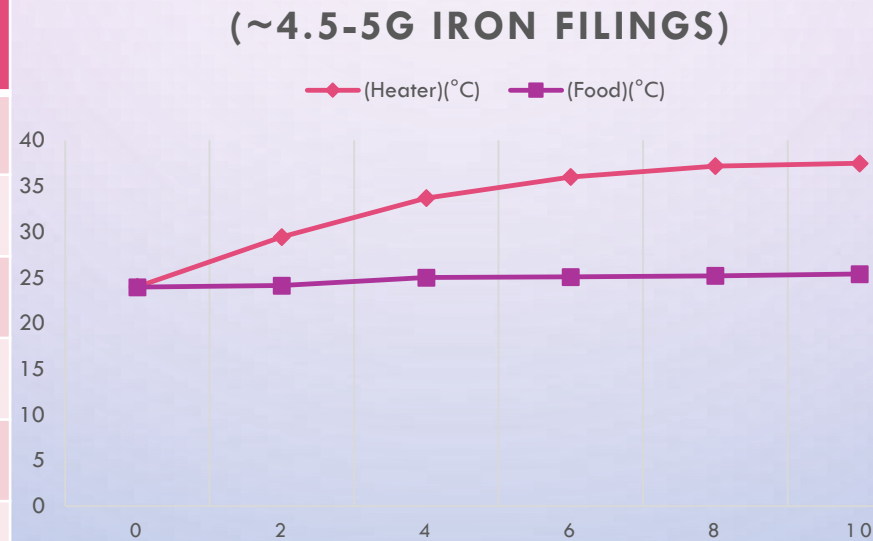
Design a Package?
Or even a double
package?

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



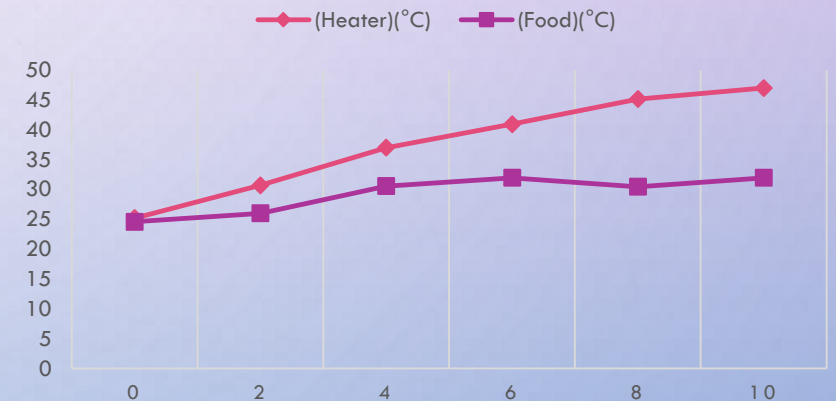
TEST02

(~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

~22.5-25G IRON FILINGS



- 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 (°C)	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 (°C)	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 (°C)	21	21	21	21	21	21

EXTENDED ACTIVITIES

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 (°C)	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 (°C)	21	21	21	21	21	21

6	鐵	活性碳	鹽	水	蛭石
	O	O	O	O	X

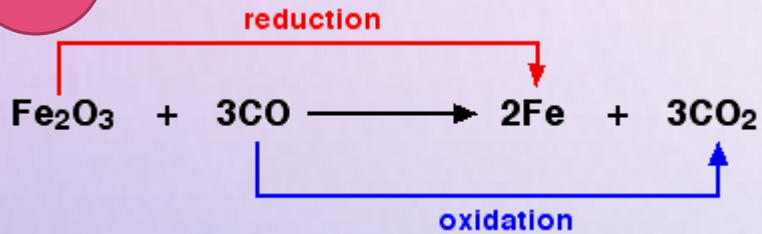
時間 (分)	0	2	4	6	8	10
溫度 (°C)	21	25	31	36	34	34

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 (°C)	21	21	21	21	21	21

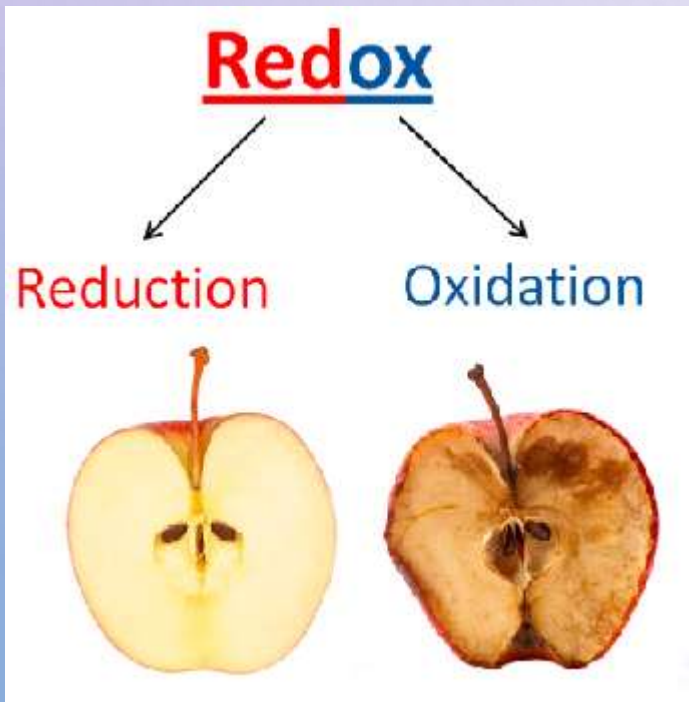
EXTENDED ACTIVITIES

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.



Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 H																	2 He
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba	* 71 Lu	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra	* 103 Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og
			* 57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb		
			* 89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No		

2

THERMAL INSULATION/HEAT CONDUCTION MATERIAL



Good/poor heat conductor



Good/poor heat conductor

102号通格

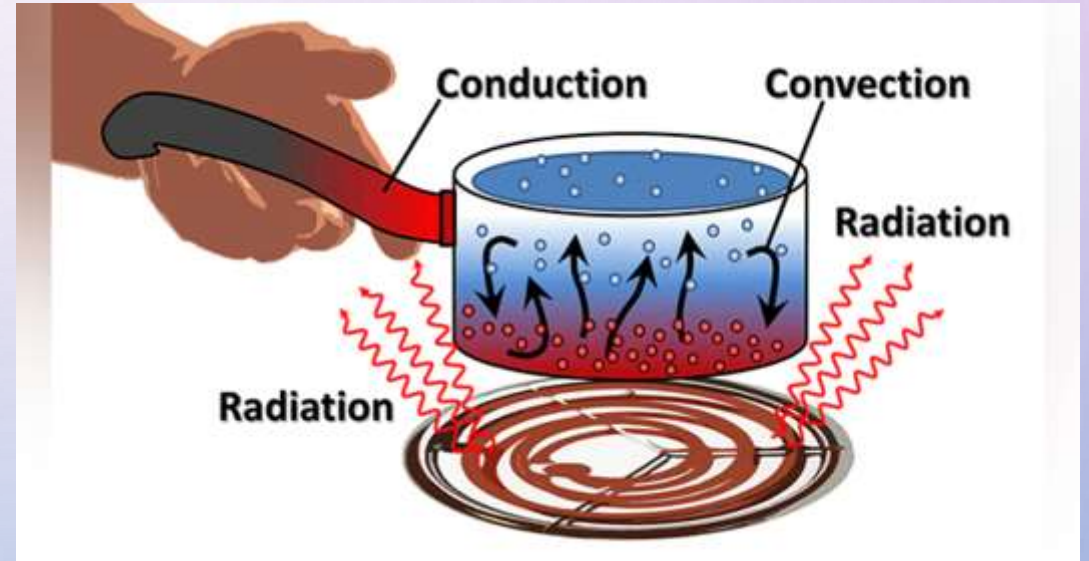


含盖高度: 82mm
内盒容量: 800ml

(2.1) GOOD/POOR HEAT CONDUCTOR

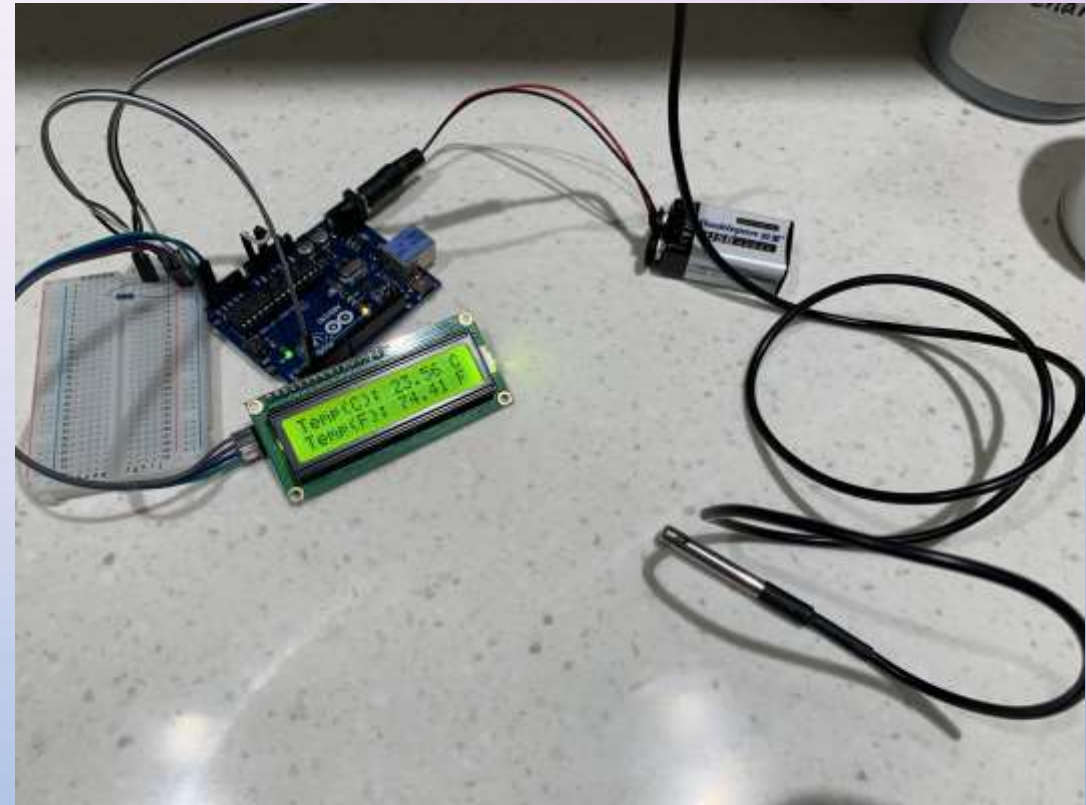
(2.2) HEAT TRANSFER

Can heat travel through all materials?



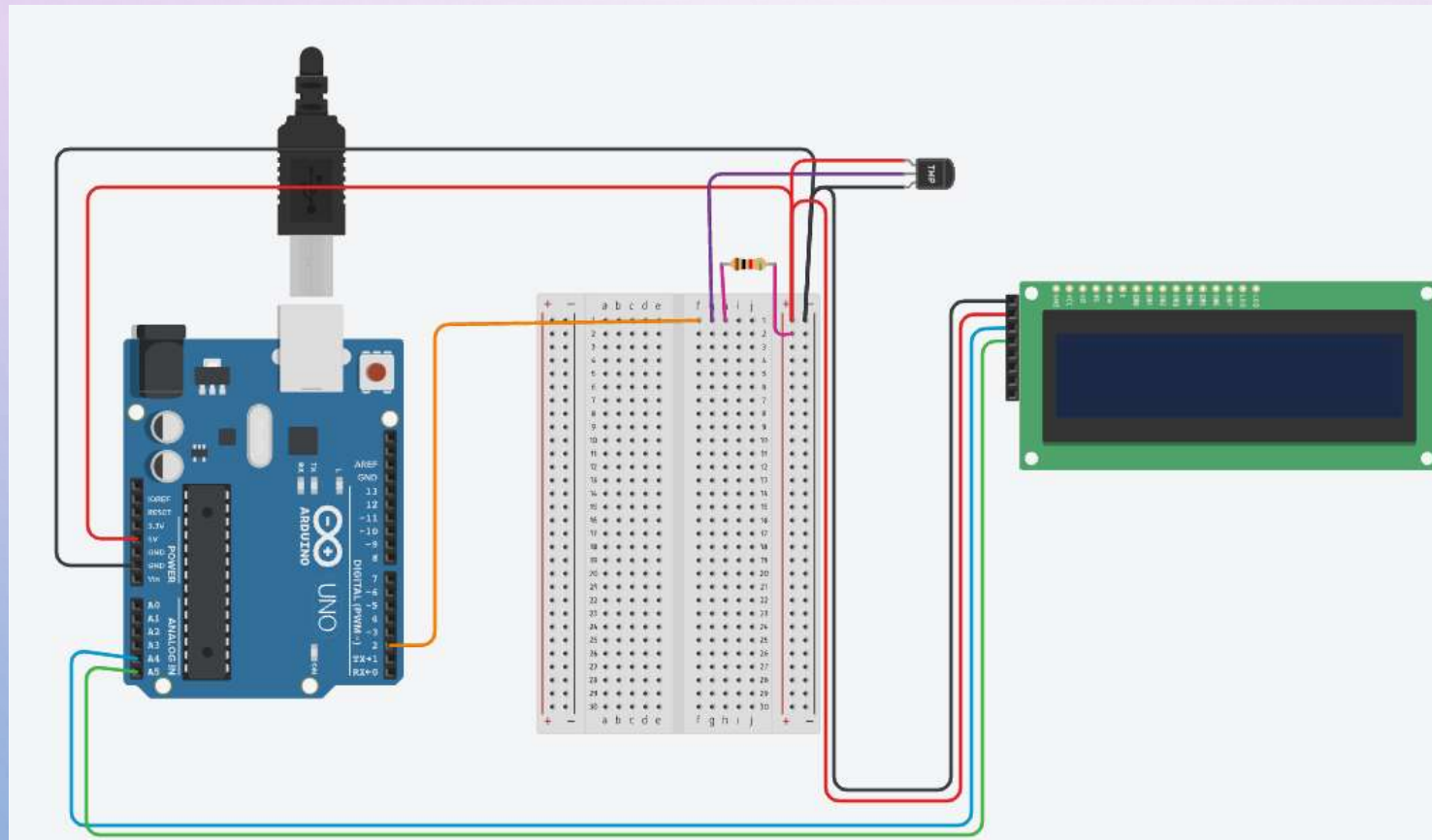
3

TEMPERATURE SENSOR - DS18B20





CIRCUIT



Made by
Tinkercad





CODING

```
test07 (Arduino 1.8.16)
File Edit Sketch Tools Help

test07
#include <OneWire.h>
#include <DallasTemperature.h>
#include <LiquidCrystal_I2C.h>

LiquidCrystal_I2C lcd(0x27, 20, 4);
// Data wire is conncted to the Arduino digital pin 2
#define ONE_WIRE_BUS 2

// Setup a oneWire instance to communicate with any OneWire devices
OneWire oneWire(ONE_WIRE_BUS);

// Pass our oneWire reference to Dallas Temperature sensor
DallasTemperature sensors(&oneWire);

void setup(void)
{
  // Start serial communication for debugging purposes
  Serial.begin(9600);
  // Start up the library
  sensors.begin();

  lcd.init();
  lcd.init();
  lcd.backlight();
}

void loop(void) {
  // Call sensors.requestTemperatures() to issue a global temperature and Requests to all devices on the bus
  sensors.requestTemperatures();

  lcd.setCursor(0, 0);
  lcd.print("Temp(C): ");
  lcd.setCursor(5, 0);
  lcd.print(sensors.getTempCByIndex(0));
  lcd.setCursor(15, 0);
  lcd.print("C");

  lcd.setCursor(0, 1);
  lcd.print("Temp(F): ");
  lcd.setCursor(5, 1);
  lcd.print(sensors.getTempFByIndex(0));
  lcd.setCursor(15, 1);
  lcd.print("F");

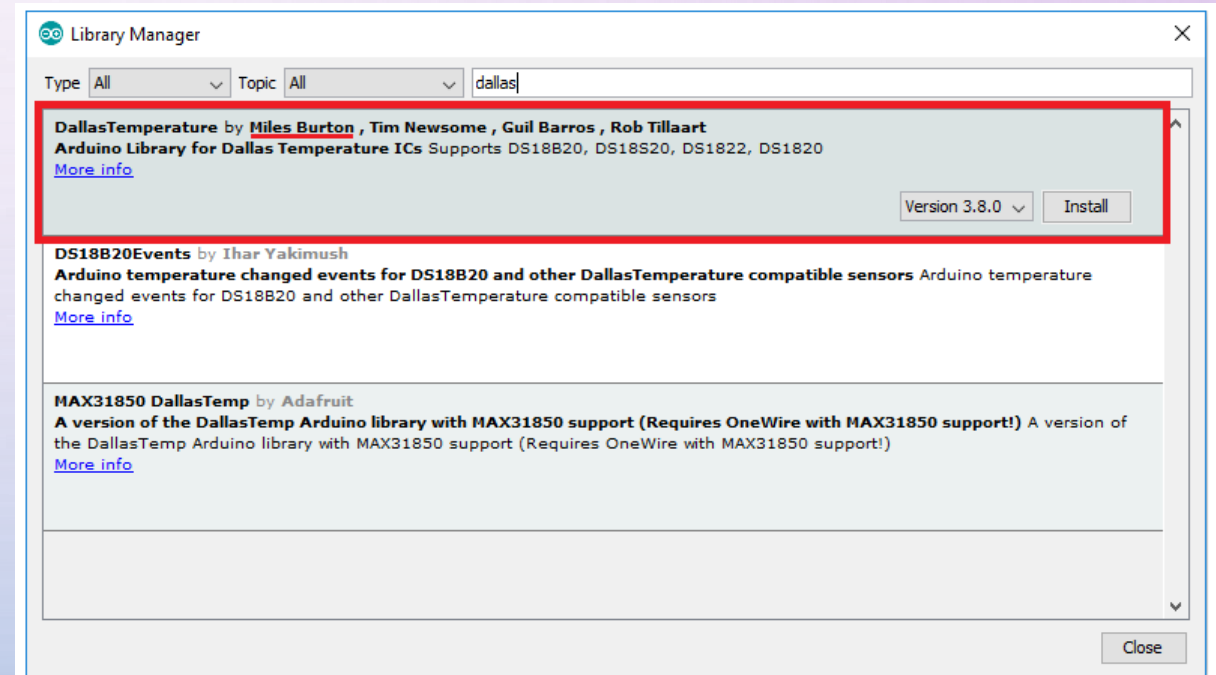
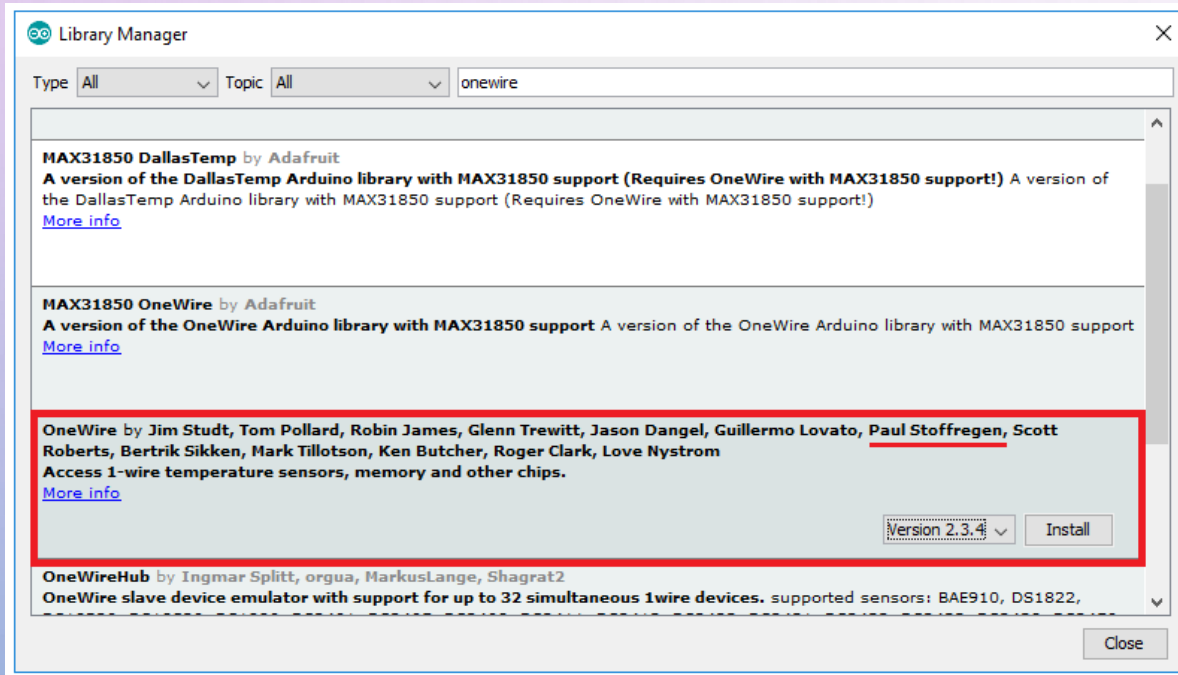
  Serial.print("Celsius temperature: ");
  // Why "byIndex"? You can have more than one IC on the same bus, 0 refers to the first IC on the wire
  Serial.print(sensors.getTempCByIndex(0));
  Serial.print(" - Fahrenheit temperature: ");
  Serial.println(sensors.getTempFByIndex(0));
  delay(1000);
}
```

```
COM13
16:54:15.728 -> Celsius temperature: 29.69 - Fahrenheit temperature: 85.44
16:54:17.507 -> Celsius temperature: 29.62 - Fahrenheit temperature: 85.32
16:54:19.289 -> Celsius temperature: 29.56 - Fahrenheit temperature: 85.21
16:54:21.073 -> Celsius temperature: 29.50 - Fahrenheit temperature: 85.10
16:54:22.852 -> Celsius temperature: 29.44 - Fahrenheit temperature: 84.99
16:54:24.634 -> Celsius temperature: 29.31 - Fahrenheit temperature: 84.76
16:54:26.418 -> Celsius temperature: 29.19 - Fahrenheit temperature: 84.54
16:54:28.201 -> Celsius temperature: 29.19 - Fahrenheit temperature: 84.54
16:54:29.975 -> Celsius temperature: 29.12 - Fahrenheit temperature: 84.43
16:54:31.753 -> Celsius temperature: 29.12 - Fahrenheit temperature: 84.43
16:54:33.531 -> Celsius temperature: 29.04 - Fahrenheit temperature: 84.31
16:54:35.318 -> Celsius temperature: 29.06 - Fahrenheit temperature: 84.31
16:54:37.144 -> Celsius temperature: 28.94 - Fahrenheit temperature: 84.09
16:54:38.925 -> Celsius temperature: 28.87 - Fahrenheit temperature: 83.97

Autoscroll Show Timestamp Newline 9600 baud
```



INSTALLING LIBRARIES



EMERGING DESIGN COMPARISON

