Horizon
Fuel Cell Technologies

Thermal Power Science Kit
ASSEMBLY GUIDE

CE

Model No.: FCJJ-38

⚠ Warning

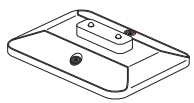
To avoid the risk of property damage, serious injury or death:

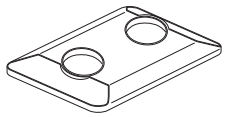
1. Read carefully and fully understand the instructions before assembling this kit.
2. Keep small children and animals away, because this kit contains small parts that could be swallowed.
3. This kit is intended only for use by persons 14 years old and up, and only under the supervision of adults who have read and understood the instructions in this user manual.
4. When assembling this kit, tools may be used. Extra care should be taken to avoid personal injury.
5. Some parts are small and fragile: please be careful when handling and connecting parts to avoid breakage. Handle all parts and components with care.
6. Do not attempt to use any part, item, or component provided in this kit for any other purpose than what is instructed in this manual. Do not attempt to disassemble any part, item or component in this kit.
7. Take care with the hot water and the thermometers.

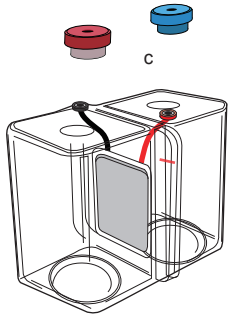
Thermal power science kit

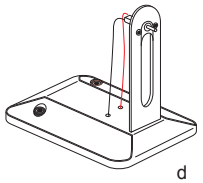
List of Component

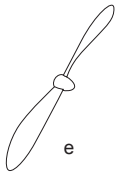
a. LED module
b. Water tank base
c. Water tank seals
d. Fan module
e. Fan blade
f. Thermoelectrical system
g. Thermometers
h. Wires

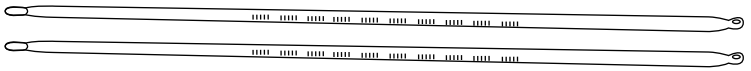

a

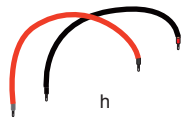

b


c f


d


e


g


h

You will also need the following items for various experiments (not included in this kit):
- Purified or distillated hot (above 85°C) and cold (below 10° C) water
- Water containers
- Boiler
- Ice cubes
- Renewable energy monitor
- 0 - 2 A ; 0 - 4 V electrical generator
- Two K-type thermocouple

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IMPORTANT NOTES:

1. Take care with the hot water to not hurt yourself.
2. Wearing waterproof gloves and glasses are highly recommended
3. There is a risk of being burned by the hot water.
4. Thermometers are fragile and if you break them, there is a risk of personal serious injury.

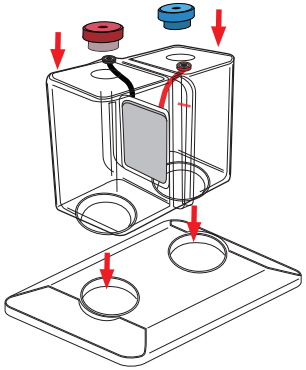
Prepare the water

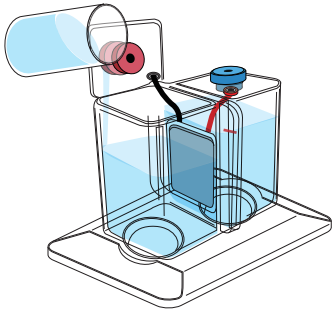
In the first container, put water and ice cube. Use the boiler to obtain very hot water and pour it inside the second containers. Add one thermometer in each containers and wait until the temperature reach the appropriate level as required. Hot water should be above 85℃ and cold water should be below 10℃.

Experiment 1 : Create electricity from two different heat sources

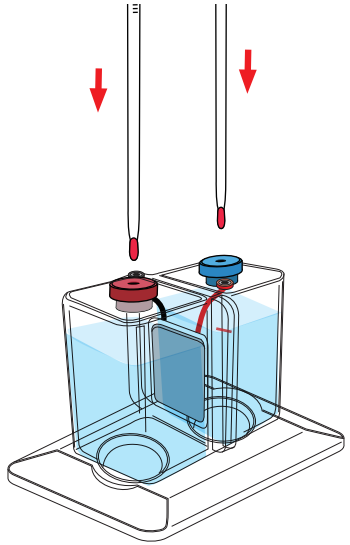
Preparing the thermo-electrical module

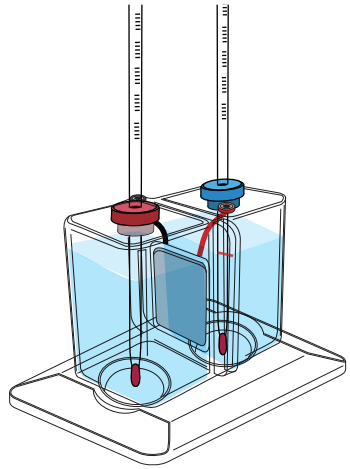
a. Insert the thermoelectrical module into the slot on its basis.
b. Put the seals insides the holes you can see on the top of each tanks of the thermoelectrical module. Ensure you place the blue seal in the red socket side hole and the red one into the hole of the black plug side.
c. Pour the water in each water tank in the thermoelectric system and ensure to fill the tank in the appropriate sense e.g. the cold water in the tank which shows the blue seal (red socket side), and the hot water on the opposite side (red seal and black socket). Ensure the central component is completely recovered by the water and the hot and cold water reaches the water level line marked on the water tank.





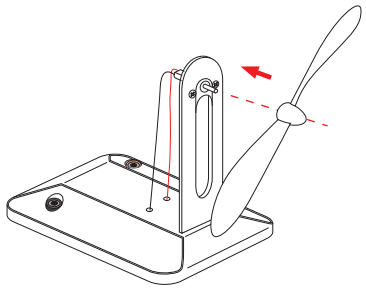
d. Insert the thermometers in the holes of the seals carefully and slowly until it almost reaches the bottom of the tank.
Note: Thermometers are fragile and if you break them, there is risk of personal serious injury.



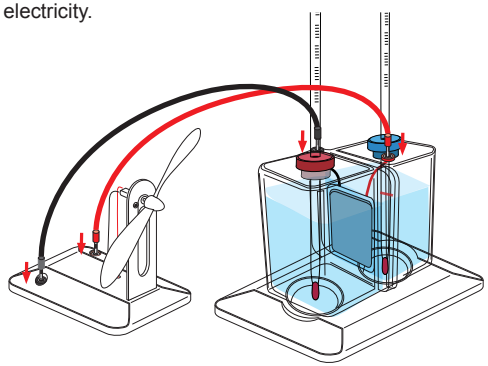


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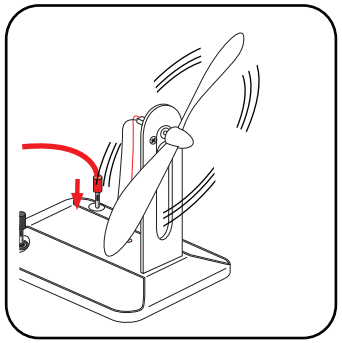
Preparing the fan module:
Remove the fan module from its box and insert the fan blade onto the motor axis. Ensure the connection is tight.



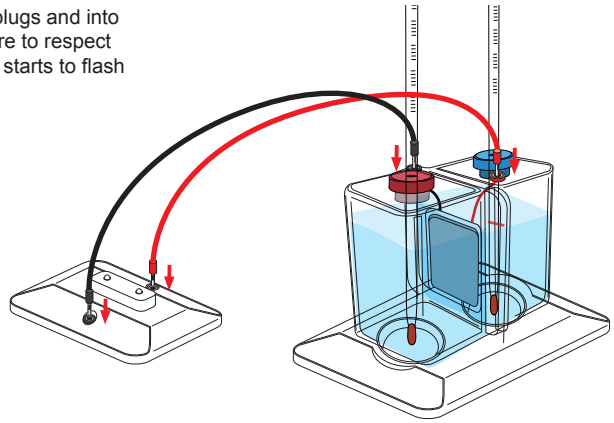
Power the fan with two heat sources:
Connect the wires into the fan plugs and into the thermoelectric system sockets. Ensure to respect the color code. You will see that the fan start to rotate immediately. It is due to the Seebeck's effect which turns heat into electricity.



Note: At this moment, the temperature difference between the two sides should be more than 70˚C.
The temperature difference is proportional to the generated power. A 70˚C **difference of temperature is enough to power the fan for a long time. The power is generated due to Seebeck's effect which turns heat into electricity.**



Power the LED module with two heat sources
Connect the wires into the LED module plugs and into the thermoelectric system sockets. Ensure to respect the color code. You will see that the LED starts to flash immediately.



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Experiment 2:
Do the same as in experiment 1, but this time connect the renewable energy monitor in order to be able to see the generated power. After connecting the wire and the fan, write every 2 minutes the temperature of each heat sources and the corresponding value of power which is generated.

Time [minutes]	T_{hot} [°C]	T_{cold} [°C]	Temperature difference [°C]	Generated power [W]
0	90	10	80	
2				
4				
6				
8				
10				
12				
14				
16				
18				
20				
22				
24				
26				
28				
30				

Note: The temperature difference between the two water tanks will be narrowed with the time going, the electricity produced will also be reduced. The fan or LED light will operate in a weak way gradually until it stops.

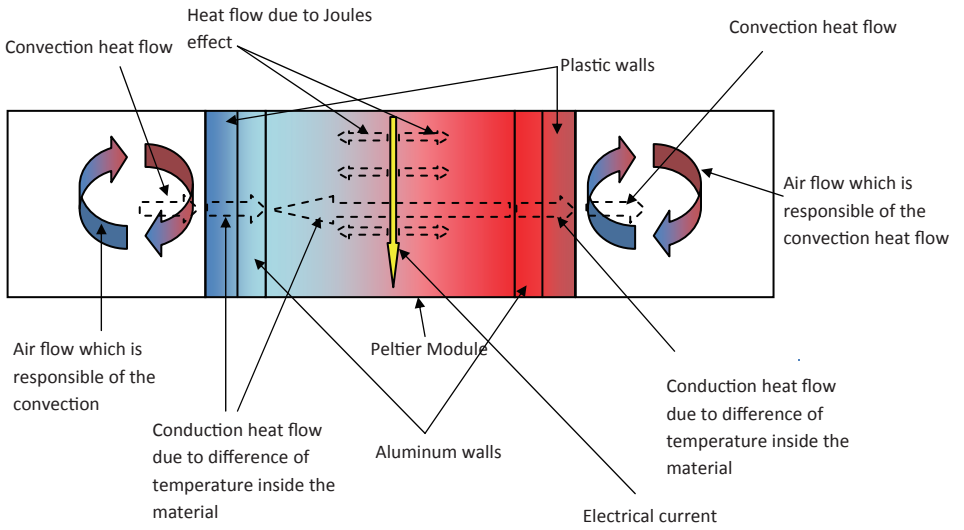
Experiment 3:
a. Do the same as in experiment 1 but connect the wires on the fan basis on the opposite sense than the one showed by the color code. You will see the fan start to rotate on the opposite sense. It is due to the motor ability to run when it is crossed by a current, no matter which direction it came from.
b. Disconnect the fan and connect the LED module to the thermoelectrical generator. Ensure to respect the color code. You will see the LED light on then disconnect wires and plug them in the other sense. The LED will not light on because the current generated by the Peltier's module (central component of the thermal generator) goes only in one direction and LED only allow the current to pass in the other sense.

Experiment 4:
a. Connect one thermocouple on each side of the Peltiers module, on the middle of the walls inside the tanks.
b. Connect the electrical generator into the plugs of the thermoelectrical system. Input different current and write the value of the wall temperature. Wait 5 minutes between the time you increase the current and the moment when you write the temperatures.

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Current [A]	Cold face temperature [°C]	Hot face temperature [°C]
0		
0,25		
0,5		
0,75		
1		
1,25		
1,5		
1,75		
2		

You will see that temperatures start to vary as soon as you power the system. It is due to the reverse effect of Seebeck's one: Peltier's effect with occurs in the junction between two materials with are submitted to an electrical current. You will notice also that one side became colder and the other become warmer. It is absolutely normal with this kind of module. The last point to notice is the cold temperature decrease in first and after start to increase again even if it stay lower than the other side one. It is mainly due to thermal effect (conduction) inside the material and electrical effect due to the passing current (joules effect). In fact heat exchange start as soon as there is a difference of temperatures, and joules effect occurs every time a current pass through a resistive material. You can see a model which sum up all the heat exchange during the experiment (except radiation).



FAQ

1. What is a Peltier Module? What is SEEBECK effect ?
Peltier module is an electrical component wade with semiconductor. It is used to create heat when you input electricity inside. SEEBECK effect is a physical phenomenon which could be described by the appearance of a current in the junction between two materials when it is crossed by a heat flow.

2. What is a dipole? Do there is different types of dipoles? If yes, classify the dipoles contained in this kit.
Dipole is an electrical component which is made with 2 terminals. There is two kinds of dipole, the active ones and the passive ones. The first type of dipole is able to generate an electrical current and the second one can just receive current.

Dipole name	Type
Peltier module	Active
Fan motor	Passive
LED	Passive

3. What is a semiconductor? What is a PN Junction?
A semiconductor is a specific material which shows a special ability to react with its environment. This kind of material has a specific atomic structure with a lack or an excess of electrons. When this kind of material receive some energy (light, magnetism, thermal energy…), the electrons on the valance band (highest layer which could be completely filled with electrons) goes on the external layer called conduction band. When electrons reach this position, they could flows inside the material. In other words, the material becomes more conductors when the electrons reach valence band. Some semiconductors are made with several elements which have not the same number of electrons. If the added element shows a higher number of electrons, there is a local excess of electrons and the material is called n-type doped material. On the opposite side, the p-type doped semiconductor shows a lack of electron around the added element because this one has a lower number of electrons. A PN junction is composed of two semiconductors fixed together. When there is some energy which goes into the junction, both materials react becomes conductor. Due to the difference of electrical potential between the Positive (p-type) and the negative (n-type) part of the junction, a current appears.

4. What is the central component of the generator? With what physical effect does it function? Quote another thermoelectric effect.
The central component is a Peltier Module. It works due to SEEBECK effect, which is the complementary effect of PELTIER effect.

Troubleshooting

After the hot water and cold water was poured into its water tank, the fan load does not work.
Solution: 1. Make sure all connections are correct.
2. Make sure the hot water is poured into the water tank with red seal and cold water into the water tank with blue seal.
3. Make sure the temperature difference is higher than 70˚C.
4. Tap the fan blade with your finger to move it.