## Folding Christmas Lantern

Please find enclosed 1 X folding Christmas Lantern + 1 paraffin wax candle power source.



## **Merry Christmas**

Figure 1: Lantern in flat configuration (left) and folded in operation (right)

Your lantern may have been sent as a flat pack. If this is the case, please assemble as follows:



8. Middle heat exchanger in position and over fastening holes



Figure 2: Assembly process for Christmas lantern (note actual lantern may differ).

Once folded/assembled into final state, go into a completely dark room (**pitch black**), light the candle and locate under the lantern's legs to start transferring heat to the Peltier module.

Heat flows through the base plate and Peltier module before transiting out of the heat transfer fins. The heat flow causes the Peltier module to generate a small voltage which is amplified by a boost converter before powering the LED.

Wait for about 1 minute or so and (hopefully) the lantern should light up. If the light fails to come on, call technical support (**07830 840 311**).



Please heed following warnings before use

Warning 1: Failure to operate in a completely dark room will lead to disappointment.

**Warning 2:** The fins have just enough surface area to stop the Peltier module from cooking so <u>please</u> <u>don't cover them</u> with anything or it might melt.

**Warning 3:** Whilst this lantern has been tested – it is not advised to leave unattended for extended periods indoors or anywhere near flammable stuff.

Warning 4: The pointy bits on the top are quite sharp and pointy!

Warning 5: Don't let it get too wet!

Warning 6: Probably not suitable for children.



Most of the lantern is recyclable being largely made of Aluminium – the other bits and pieces can be recycled by your nearest WEEE facility.

## The power of tea candles

- 1) A tea candle produces ~20W of power output by way of raw heat.
- 2) The candle will stay lit for 3-4 hours which equates to about 0.07kWh of energy. At the time of writing, you could buy 500 tea candles from Amazon for £35. This implies a cost of about £1/kWh which, even at today's exorbitant energy prices, is about 3 times the cost of domestic gas. So no, the internet is wrong, you can't heat your house cost effectively with tea candles and a flowerpot.
- 3) Tea candles are nonetheless quite impressive. Duracell's best AA batteries can deliver 2,500mAh which is about 0.00375kWh (10 to 20 times less energy than a humble tea candle!).
- 4) However, Peltier modules are not very efficient. They melt at around 120°C which means you can't get much efficiency out of them. Assuming you're in a 15°C room, the best you could theoretically get is 27%. In practice, given the limited bandwidth of the semiconductor in the module and other losses, you might achieve ~5%-10%. This takes us from 0.07kWh to ~0.0035kWh, pretty much back to where we were with a single AA battery.
- 5) Factoring the above efficiencies, from our ~20W power input, we get ~1W to 2W of electrical power output from the Peltier module but at a pretty measly 0.3V to 0.8V.
- 6) We need to boost this up which we do with a little 'boost converter' under the LED (wrapped in black heat-shrink). This is a little inductor, transistor, diode and a small microcontroller which pulses power into the inductor to step up the voltage to ~3.5V.
- 7) The original objective with this lantern was to get more visible light out from the LED than from the flame out of the tea candle... Not sure this has been achieved in this version but should theoretically be possible with a bit of refinement! Again, please heed warning 1 above!

**Note:** Future upgrade LED module is being worked on, this should increase light output and may be available for Christmas 2023 depending on electronic supply chains by that point.