# Incubator for Off Gassing of Materials

### Supplies

|  |  |  |
| --- | --- | --- |
| Hardware | Price $ | Amount |
| [Air Heater/ Fan (PTC Car Heater 12V 100W)](https://www.amazon.com/Constant-Temperature-Heating-Element-Conditioner/dp/B0BJ9ZFMSC?crid=2K6CRU64ANUCN&dib=eyJ2IjoiMSJ9.0aHwXBvWiWG_woTTtsVSKkGbXd6b6ysJTu9DVvcqu68iUlZm7ZzfPMFGF1jIh1Uaq8zaZ4p7OdlQOL8NLqX6fYDs6nwV-KFxK1adOyaC02wlQXYpH_Zjm793OhFYmtzj3c9VwJIOoDQ1I_N08ngzfGVGSgWutG-b9dZF4znz7t9kSkzAEPbNOJs8j0rFVT5Df4TZuB-Wh3d9WwTqGoXY7IbI8C2ju3DQHtRaud6LgzY.ujYMx9v5XUMJUEfJvaMl2yJaXBoPHv76pcLLQNZoMcU&dib_tag=se&keywords=car%2Bheater%2Bdc%2Bfan&qid=1743445107&sprefix=car%2Bheater%2Bdc%2Bfan%2Caps%2C146&sr=8-3&th=1) | 23.73 | 1 |
| [Adjustable Power Supply](https://www.amazon.com/Adjustable-Universal-Switching-Minidodoca-Electronics/dp/B0C5QG946M?crid=2K3KHQ17WE61U&dib=eyJ2IjoiMSJ9.DNh848MMmHfoWUFRGYuBm8z6kFKj9Av5-4-kXPIw3EnkC-XwU8HYKydIQqCIw1ajzpnWLUTfSlEVo5i_BGwfKfTBo7vBo-dsUuOxoLjhoMwOlVqUbKGWXJ2w2D-R9NCSM88iqvonVzIT7yXlbv7XvWefCmgDo08s4P6ksoF6p_CXsHx7EqddIyV5jDPIU_YVMkYQgKl-V3ccEN3YKyb70-gXCgOEsNCgkv6bCq9UPMw.YYik0rma0JelhmRKPw6GkOrZLFjYIxeNXwXpX1OzhIg&dib_tag=se&keywords=12-24%2Bpower%2Bsupply&qid=1743122672&sprefix=12-24%2Bpower%2Bsupply%2Caps%2C226&sr=8-1-spons&sp_csd=d2lkZ2V0TmFtZT1zcF9hdGY&th=1) | 15.99 | 3 |
| [Coleman Cooler](https://www.amazon.com/Coleman-Insulated-Portable-Retention-Heavy-Duty/dp/B09HN1BPJT?adgrpid=1341404757585210&dib=eyJ2IjoiMSJ9.Df_GB5YpYI4NlMMpLFP3xU0x5_YxQ6T7gJg6fD1U3MWwrVZ1VttHcyVfu8YiAJltEGkWbK0itFPn1lFDeF-lqUTKTSctcXrBixP6WISuu32VKbbBBWDndpRoB9uK--tVoNCNikMb3OQPWW8QUQIrKpA46LGk69i3PztIoyLs2VPy6W6wNh6RqhqsTlmwgD-CXus6Nyd6aHSKtucjDXmlqcllXnhhBuKCgED0-eicwmLaQew_V_PuGu1fPLtf82U_kDx-YpLbIgNcJukAoMVlCg3wr0gA5Jnrw37CSEsqbnSlEZpyD-lGZy1vyrWmaMlraWsKQMtaW4PcW4g9hbIoVWF0b6n_xc073XPZxOaROnRhxt9csBrHsp-vz-dnx5yY8SJE4hIq-Uu6SaxtIlWfyKrZNPHDA2ABwLxw0kLHErgcJvthwFtkKHXvRity0Z8W.Va-nPea3aUerMsfs6KvEPEG2AN4gBrgbj-_qCN9kDbU&dib_tag=se&hvadid=83838011721171&hvbmt=be&hvdev=c&hvlocphy=79724&hvnetw=o&hvqmt=e&hvtargid=kwd-83838156365104%3Aloc-190&hydadcr=7974_13465310&keywords=cooler%2Bamazon&mcid=08ee30f69a02385fb8185d3ab8c7c925&msclkid=d841dc251f9e19b5765fbbc614921e6c&qid=1742932756&sr=8-5&th=1) | 39.99 | 1 |
| [PTFE Film Adhesive](https://www.mcmaster.com/2208t72/) | 58.27/ foot | ~20ft |
| [BOJACK DS18B20 W1ThermSensor](https://www.amazon.com/BOJACK-Temperature-Waterproof-Stainless-Raspberry/dp/B09NVWNGLQ?crid=3IPDN4UPB4PR0&dib=eyJ2IjoiMSJ9._BHkpX87ZF_FWtkVbJHjSUmvuhgofNB4EACCN5v2fjYs6XImHLROMmQ8xPzCz5E0D39Np31aq3rghp5N50e6b7qKGLahCFUVDpk9vxnYxYzT5F6y5CY8LqkLRKmq13wAjGQLnp6RmtOdQxI0UbjON5SoJbQrhAjFmPTO-na2HQbk6XggCg714uYLUZir-aZlbzJ5g9uqiCxulEdHSNA-uZFcX6iHcGZh8hKoqZDydck.6OA9o0UtomHYxwofOM1gm4YM_JsWOmJBqnH1I9WOE58&dib_tag=se&keywords=DS18B20&linkCode=sl2&linkId=b519872686133290518655b929a141e4&qid=1744242423&sprefix=ds18b20%2Caps%2C352&sr=8-1-spons&sp_csd=d2lkZ2V0TmFtZT1zcF9hdGY&psc=1) | 8.99 | 1 |
| [4.7K Ohm Resistors 1/2W](https://www.amazon.com/EDGELEC-Resistor-Tolerance-Multiple-Resistance/dp/B07QJB3LGN?crid=18R62Z30G3YR8&dib=eyJ2IjoiMSJ9.ZnibiSU-ptDh5dmQv54nb0udEFgK5LUIQspwGcySaZoym3AGRe25BGTV1T9i4GQBFSSQD-JaKhUUopkvHRiNn1wWQ2qQPHBmakm7B4Dw8AC-4mxLvh12-TEGrCbuatEz92ZKFk6JW1xMTirTLxtWUdeeNfIC1BVScgE8Cy2J9Lb7GTwMPCq0Ob4yO7lz5jUvqppa18ZdvLSxDxC7LeyTNEQc_bcy9-7t2Nvo2Xsx620.WMNbOsnySwsiGb4rglx-f8qjKtxDrOoieFJPBsWNIOw&dib_tag=se&keywords=4.7k%2Bohm%2Bresistor&linkCode=sl2&linkId=638e09a43765157c1f0d8b75349ac9a8&qid=1744242477&sprefix=4.7k%2B%2Caps%2C383&sr=8-1-spons&sp_csd=d2lkZ2V0TmFtZT1zcF9hdGY&th=1) | 5.99 | 1 |
| [2 Channel 5V Relay](https://www.amazon.com/SunFounder-Channel-Optocoupler-Expansion-Raspberry/dp/B00E0NTPP4?crid=2CVU69SNYBV6H&dib=eyJ2IjoiMSJ9.HosleteetjBLsU7osiwCjQ.PdZyq3Y4Yv4b84MFwRqNmoHv_myKaSaxWzw9QOicWuA&dib_tag=se&keywords=B00E0NTPP4&qid=1750698202&s=electronics&sprefix=b00e0ntpp4%2Celectronics%2C202&sr=1-1&th=1) | 6.79 | 1 |
| [Breadboard Jumper Ribbon Cables](https://www.amazon.com/California-JOS-Breadboard-Optional-Multicolored/dp/B0BRTJXND9?dib=eyJ2IjoiMSJ9.2MH2I_tHSWhpR6PddqIFguN3OIu3rPkt60XgUt1-miKLnVFhQdi5WO1o9sHrpsRwEFI1Kso_GPSlVj9WaAWLiwYAuwHbSd-l-qxuPqjJ3zXPUJY_-e7Rot0LiVq5hkYmMtLs2SZej9IZH8VJ7aBgNr0619vg8K84ld7dtHiyuwqaBFUW8HPU8Ifevh7xWVXiV-sWWpf5VhDP2jlbfxTyTeSLF_Njn3toP5S0ZVj31oI.DKkHz0X6D3kZWlW6o_y7dbPbXynyquYvX2qFQYDBI58&dib_tag=se&keywords=DuPont+120pcs+Multicolored+Breadboard+Jumper+Ribbon+Cables+Kit+Compatible+with+Arduino%3A+40pin+M%2FF+%26+M%2FM+spanned&qid=1750699245&sr=8-1) | 5.97 | 1 |
| [Raspberry Pi 5](https://www.amazon.com/CanaKit-Raspberry-Starter-Kit-PRO/dp/B0CRSNCJ6Y?crid=I5R9MAWS6IR3&dib=eyJ2IjoiMSJ9.TzIAlcap-JN7BzO8wHpHCSMaWnD3Gf3VV28iQDak-L3XOnAHQXO5CuPLOYZKLMcDFYI9IqyozmNKSLjIXujezyO2b49doxZeVvVVUX5gqA54-0EjUOIOeh-Z6b-_3tB9549J5_2X5F3caNs5ohyZm-m5xAwkM60ey2A_14DZh_H9EHkVs37RMIVRKCtZfO-PJ6HzNXQFIzO3UY7q2W1qkzTDBjAG7fbjHITT2zEIpGU.I9lvmU0bOPHtCkBOf4ZW2XXFj-ZJo6PsMEKOSnxc5Mw&dib_tag=se&keywords=raspberry%2Bpi%2B5&qid=1743120165&sprefix=raspberry%2Bpi%2B%2Caps%2C311&sr=8-1&th=1) | 159.00 | 1 |
| [Portable Monitor](https://www.amazon.com/Portable-Monitor-InnoView-External-Protective/dp/B095GG31KX?th=1) | 84.99 | 1 |
| [Logitech Keyboard](https://www.amazon.com/Logitech-Programmable-Backlighting-Bluetooth-Rechargeable/dp/B0BKVZK4TH?dib=eyJ2IjoiMSJ9.BmC0O4DqBFzY2BY1zxYoXrsQrG2tibrNeQ8t6KE0W9DyoCfegWDhsExHS_QtIf90AAumY9bLGBknjfkWmNfKTaK2L4lre91VU-DzZk3BgsjpGKYQp39q0Bj3QF0sSitdx2JiUiD5YhFWj1cxwpU405KekP46ojQaNhScNZ4u0UyxftvzdTj_sBiG3Bx6grDQ_ayQ7Se_MdO6gnv-_L6S05wDAFFNLvX5ecBy_whNqPc.p9UFN812M-R7dqTuR4Dnzj03-O9UAaTtr8RcSnvR1vU&dib_tag=se&keywords=logitech%2Bwireless%2Bkeyboard&qid=1750698535&sr=8-6&th=1) | 129.99 | 1 |
| [Logitech Mouse](https://www.amazon.com/Logitech-Wireless-Mouse-M185-Swift/dp/B004YAVF8I?crid=1N5G4IRY82390&dib=eyJ2IjoiMSJ9.AqyGWlUbutkOOgaMenM6rBhs30v61FcZ0XRMdF4eoNBBrn95Jv5JmadCxKJe4qEwwNA3bYWhz07xOhr2o_3Ndot83gtbEmCQ7H1soTrSrfCsHy54vWXgtRnDoadTPDxgeoONkhn-_mCqXiVG5w_yiSpIDqNnkjHrMtiJcFCynJ_RuSaHIg3GT8Ke1n-B9FnNxxPTnK-_SQRcuyD-J3dk4_0rSxy8RSP-8kkhawn17K0.1jJlKOGLQyfG2JMyNI_NBN_-CkOpqXvUhh5j9hkkTcg&dib_tag=se&keywords=logitech%2Bwireless%2Bmouse&qid=1750698568&sprefix=logitech%2Bwireless%2Bmous%2Caps%2C179&sr=8-4&th=1) | 13.40 | 1 |
| [GPIO Breakout Kit for Raspberry Pi](https://www.amazon.com/UCTRONICS-GPIO-Breakout-Kit-Raspberry/dp/B07DL25MVQ?crid=1VWBF33L6CTGF&dib=eyJ2IjoiMSJ9.mxR5EYpZoYAHpCUcc8j-mkVb-mpmcDSijWinhEricd0SxGCuidNYCB58eQDwkx0ahUD3ceBE2e9P4yT93lMQziZboiG4LHW1cXT_xC56YORbpVBQHm4HsqK1LkInGtJ49nXuLk6ayfOLasMvj7VsdEKHKja95FINHyOUO5GVUFx00Kr7iB_1T_kzI1WN41XfNafalTB5bRFDW1nvzgnVwBtdvF-oZV9EcgzEfrbJQIs.S6dTTjn20JeYFSeI5Oo-aL1C45xnOWzxkgwwTtkkRUI&dib_tag=se&keywords=GPIO%2BBreakout%2BKit&linkCode=sl2&linkId=40a7640b014f5c3a5f6e21eb73ad0dd3&qid=1744242543&sprefix=gpio%2Bbreakout%2Bkit%2Caps%2C563&sr=8-8&th=1) | 9.99 | 1 |
| [1/4" Tubing OD to 1/4 NPT Male fitting](https://www.mcmaster.com/5016k422/) | 4.90 | 2 |
| [1/2 NPT Male to 1/4 NPT Female Adapter](https://www.mcmaster.com/46885k252/) | 3.88 | 2 |
| [1/2 NPT Female Through-Wall Fitting](https://www.mcmaster.com/36895k141/) | 35.44 | 2 |
| [1-3/8" Diameter Hole Saw](https://www.mcmaster.com/4008a283/) | 16.27 | 1 |

Heater-control-w1thermsensor.py provides a solution for controlling a relay-based heater/fan system using a temperature reading from the w1thermsensor. The system is designed to maintain a desired temperature range by turning the heater on or based on the predefined threshold while Zero air runs through the cooler.

### Features:

* Temperature monitoring: read\_temperature reads temperature from W1ThermoSensor connected to specified GPIO pin, log\_temperature records temperature as a function of time to a CSV file
* Relay control: control\_relay activates or deactivates a relay connected to specified GPIO pin based on a specified temperature range
* Configurable threshold: bariables TEMP\_UPPER\_LIMIT and TEMP\_LOWER\_LIMIT allows for easy adjustment for the temperature threshold at which the relay could be switched
* Error handling: Includes a retry mechanism and SensorNotReadyError pass statement for W1Thermosensor readings to improve reliability
* GPIO cleanup: Ensure proper cleanup of GPIO settings upon program termination

### Run code

* All Code was written and run through VSCode, where the file can be downloaded as a jupyter notebook

Or

Sudo python5 heater-control-w1thermsensor.py

### Live Setups:

A close-up of a circuit board

AI-generated content may be incorrect.

**Figure 1** Live Setup GPIO Setup

A close-up of a circuit board

AI-generated content may be incorrect.

**Figure 2** Relay Controller Heater (H), Fan (F)

A computer on a table with electronics

AI-generated content may be incorrect.

**Figure 3** Incubator Setup as of 06/23/2025

### Wiring Diagram

A diagram of a computer

AI-generated content may be incorrect.

**Figure 4** Wiring Diagram using W1ThermSensor

### Incubator Diagram

A diagram of a box with drawings

AI-generated content may be incorrect.

**Figure 5** Incubator Diagram including measurements

### Through-wall Fittings Diagram

A diagram of a light bulb

AI-generated content may be incorrect.

**Figure 6** Inlet/Outlet Breakdown for Through-wall Fittings