

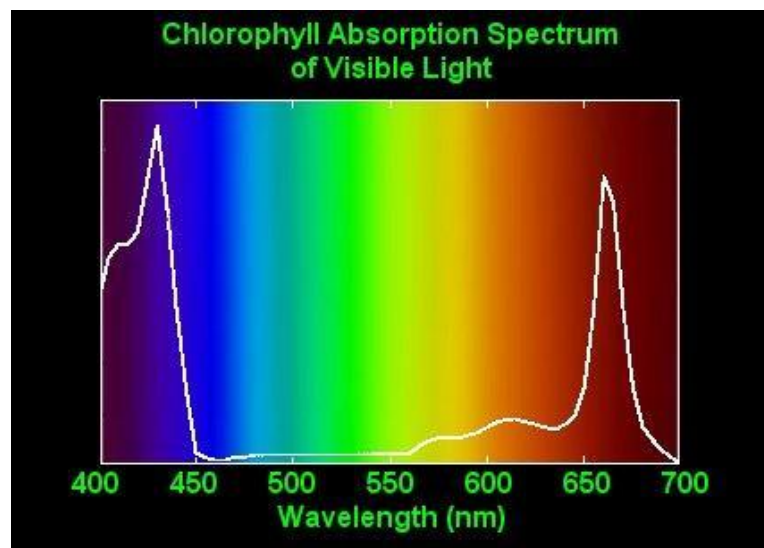
Arduino Project: Automated Garden

General Summary:

Create an indoor garden that waters and provides light for itself. It will be 3 levels high and look something like the picture below (this is not the exact design). Blue and red LEDs will be mounted above each level to provide light. Blue and red were chosen since they produce light at the required wavelengths that can be absorbed by the chlorophyll in the plant. See the graph below.

Moisture sensors will measure the moisture of the soil on each level and identify when it needs to be watered. A pump will be used to supply water to each level (may use a gravity fed system instead). There will be electronic valves for each level to control the water flow.

All electronics will be controlled by an Arduino UNO. LCDs will display the moisture reading on each level and if the water reservoir needs to be refilled. An AC to DC power source will need to be purchased since the Arduino won't be enough to power everything. The arduino will only have enough juice to power the sensors and liquid crystal displays. Transistors will be used with the arduino to control the pump, valves, and LEDs.



Require LEDs with the ranges of 380-450 nm and 640-680 nm in wavelength.

During my research, I found that the provided absorption range listed on different websites varies by a little bit.

Parts list:

[Blue LEDs](#) (450nm):

Price: 50 pieces for \$14.68

Power: 3W

Forward Voltage: 3-3.4V

Forward Current: 400-500mA

Order Status: Ordered

[Red LEDs](#) (660nm)

Price: 50 pieces for \$20.01

Power: 3W

Forward Voltage: 2-2.2V

Forward Current: 400-500mA

Order Status: Ordered

[Pump](#): This pump was too small.

Price: 1 piece for \$10.02

Voltage: 12V

Current: 80mA

Flow Rate: 0 - 100 ml/min

Order Status: Ordered

Bigger Pump: Ordered

https://www.amazon.ca/gp/product/B01MYMNNIN/ref=od_aui_detailpages00?ie=UTF8&psc=1

[Soil Moisture Sensor](#):

Price: 5 piece for \$4.41

Order Status: Ordered

[Valves](#):

Price: 3 piece for ~\$10

Voltage: 12V

Current: 600mA

Require one for each level.

Normally closed. hose barbs for 1/2" (outer diameter) hose

Order Status: Ordered

[Water Level Sensor](#):

Used to monitor the water level in the reservoir

Already own one

Liquid Crystal Displays:

Used to display the moisture readings for each level

Already own some

Transistor:

Required between the power supply and Arduino. Allows control of power to the LEDs, pump, and valves by the Arduino.

Power Supply for Watering System:

[Data Sheet](#) (12V, 5A)

Measured value: 12.3V

Power Supply for LED System:

[Data Sheet](#) (20V, 4.5A)

Measured value: 20.5V

Mounting Structure

<https://www.ikea.com/ca/en/catalog/products/30218597/#/30218597>

Shelf: 23.5 x 15 inches

Bin for soil:

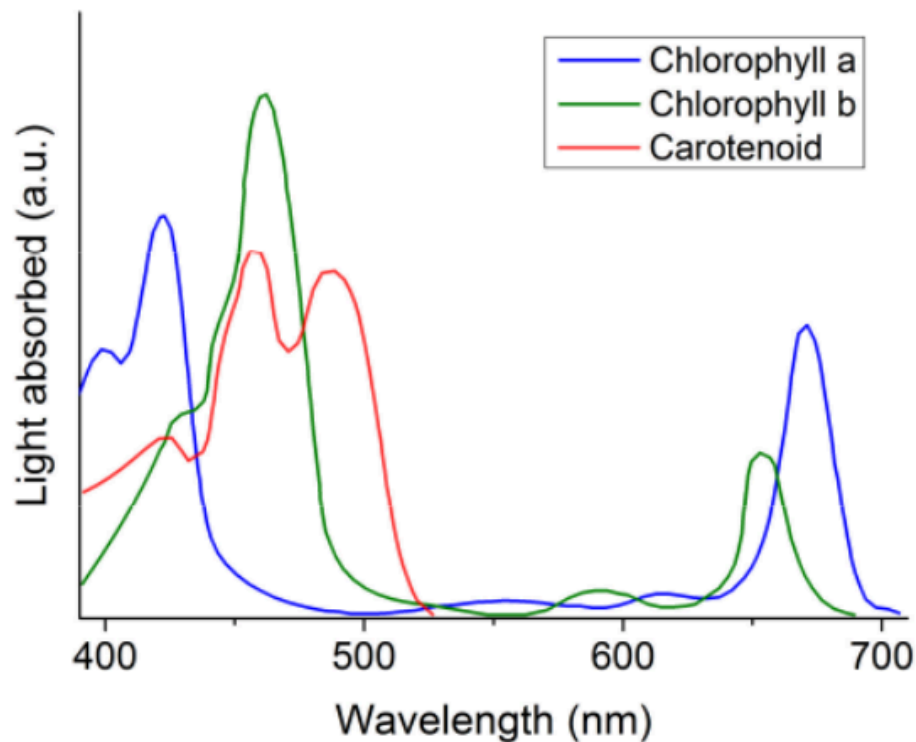
<https://www.globalindustrial.ca/p/storage/bins-totes-containers/nesting/tote-box-without-lid-5>

<http://www.ikea.com/ca/en/catalog/products/95685100/>

LED strips, red/blue:

<https://www.amazon.com/Toogod-Spectrum-16-4ft-Waterproof-Growing/dp/B00XHRYX2O>

Research:



<https://pdfs.semanticscholar.org/0446/eadd54b564cf5e5512a096f54d494c40d356.pdf>

The solar radiation spectrum mainly consists of three parts: ultraviolet (UV), visible light, and infra-red.

200–280 nm (ultraviolet C):

This part of the spectrum is harmful to the plant because of its high toxicity. UVC is blocked by the terrestrial ozone layer, so it does not reach the earth's surface.

280–315 nm (ultraviolet B):

This part is not very harmful but causes plant colors to fade.

315–380 nm (ultraviolet A):

This range does not have any positive or negative effect on plant growth.

380–400 nm (ultraviolet A/visible light):

Beginning of visible light spectrum, process of light absorption by plant pigments (chlorophylls and carotenoids) begins.

400–520 nm (visible light):

Contains violet, blue and green bands. Peak absorption by chlorophylls occurs in this range and it has a strong influence on vegetative growth and photosynthesis.

520–610 nm (visible light):

This range contains green, yellow and orange bands. This range is less absorbed by the plant pigments and has less influence on vegetative growth and photosynthesis.

610–720 nm (visible light):

Contains red bands and a large amount of absorption occurs at this range. This band strongly affects the vegetative growth, photosynthesis, flowering and budding.

720–1000 nm (far-red/infrared):

Germination and flowering is influenced by this range but little absorption occurs at this band.

>1000 nm (infrared):

All absorption in this region is converted to heat

Excellent video comparing plant growth using red, blue, white, and red/blue lights:

<https://www.youtube.com/watch?v=sfihE4luFuU>

His website:

<http://albopepper.com/>

Suggested LED wattage 25-35W for 12"x12" area

<https://www.ledgrowlightsdepot.com/blogs/blog/16326275-how-many-led-watts-are-required-per-square-foot-of-grow-space>

High Light Plants (tomatoes, etc) Require ~25 watts/sq ft (actual LED wattage)

Low Light Plants (leafy greens such as lettuce and basil) Require ~16 watts/sq ft (actual LED wattage)

Large Scale Company:

<http://urbanproduce.com/>

Association for Vertical Farming:

<https://vertical-farming.net/>

LED Circuit Calculator:

http://www.engineersedge.com/instrumentation/series_parallel_led/series_parallel_led_calculator_12931.htm

Online Circuit Creator:

<https://www.partsim.com/simulator#70135>
<http://www.schematics.com/editor/led-circuit-47232/>

Circuit Diagrams - Applet:

<http://www.falstad.com/circuit/e-index.html#3way>

Explanation of why you need a current limiting resistor with a LED and what forward voltage and current is:

<https://www.baldengineer.com/led-basics.html>

Calculate LEDs forward voltage and required resistor power rating:

<https://electronics.stackexchange.com/questions/173468/easy-way-to-figure-out-a-leds-vf-in-order-to-pick-an-appropriate-resistor>

Determining the current rating of a LED:

<https://forum.allaboutcircuits.com/threads/how-to-determine-imax-for-an-unknown-led.45081/>

Multimeter - Current measurement:

<https://learn.sparkfun.com/tutorials/how-to-use-a-multimeter/measuring-current>

Informative LED store:

<http://www.ledsupply.com/>

LED grow light kit. Full description of all parts and how to assemble. I could just make this my self:

<http://www.ledsupply.com/led-kits/grow-light-kit-makersled>

Explanation of the different types of transistors and how they work:

<https://learn.sparkfun.com/tutorials/transistors>
<http://www.electronicshub.org/transistors-classification-and-types/>

Posted my circuit design on a form for help:

<http://electronics.stackexchange.com/q/290558/141207>

Great explanation on how to pick a power source:

<http://electronics.stackexchange.com/questions/34745/choosing-power-supply-how-to-get-the-voltage-and-current-ratings>

Wire is sized by the American Wire Gauge (AWG) system. Breadboards are generally designed to use 22 gauge wire, although they can accommodate a gauge or two either way.

7A -> 22 Gauge

11A -> 20 Gauge

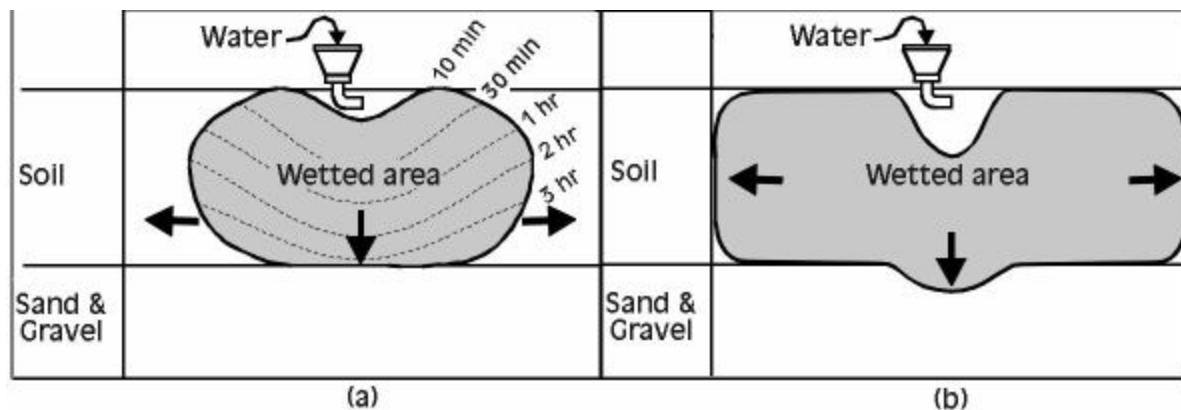
<https://learn.adafruit.com/wires-and-connections/wire-gauges>

Amazon Price Tracker:

<https://ca.camelcamelcamel.com/>

Watering

<http://croptechology.unl.edu/pages/informationmodule.php?idinformationmodule=1130447123&topicorder=3&maxto=13&minto=1>



Circuit Design: 20V power supply (LEDs)

[http://www.falstad.com/circuit/circuitjs.html?cct=\\$+1+0.000005+0.03528660814588489+50+5+50%0Aw+560+624+528+624+0%0Aw+560+336+560+624+0%0Aw+640+624+560+624+0%0Aw+704+624+640+624+0%0Aw+704+624+784+624+0%0Aw+704+384+704+624+0%0Aw+848+624+784+624+0%0Aw+848+432+848+624+0%0Aw+928+624+848+624+0%0A162+784+192+784+240+1+2.2+1+0+0+0.5%0A162+784+288+784+336+1+2.2+1+0+0+0.5%0A162+784+240+784+288+1+2.2+1+0+0+0.5%0A162+784+432+784+80+1+2.2+1+0+0+0.5%0A162+784+480+784+528+1+2.2+1+0+0+0.5%0A162+784+384+784+432+1+2.2+1+0+0+0.5%0A162+784+336+784+384+1+2.2+1+0+0+0.5%0A162+784+528+784+576+1+2.2+1+0+0+0.5](http://www.falstad.com/circuit/circuitjs.html?cct=$+1+0.000005+0.03528660814588489+50+5+50%0Aw+560+624+528+624+0%0Aw+560+336+560+624+0%0Aw+640+624+560+624+0%0Aw+704+624+640+624+0%0Aw+704+624+784+624+0%0Aw+704+384+704+624+0%0Aw+848+624+784+624+0%0Aw+848+432+848+624+0%0Aw+928+624+848+624+0%0A162+784+192+784+240+1+2.2+1+0+0+0.5%0A162+784+288+784+336+1+2.2+1+0+0+0.5%0A162+784+240+784+288+1+2.2+1+0+0+0.5%0A162+784+432+784+80+1+2.2+1+0+0+0.5%0A162+784+480+784+528+1+2.2+1+0+0+0.5%0A162+784+384+784+432+1+2.2+1+0+0+0.5%0A162+784+336+784+384+1+2.2+1+0+0+0.5%0A162+784+528+784+576+1+2.2+1+0+0+0.5)

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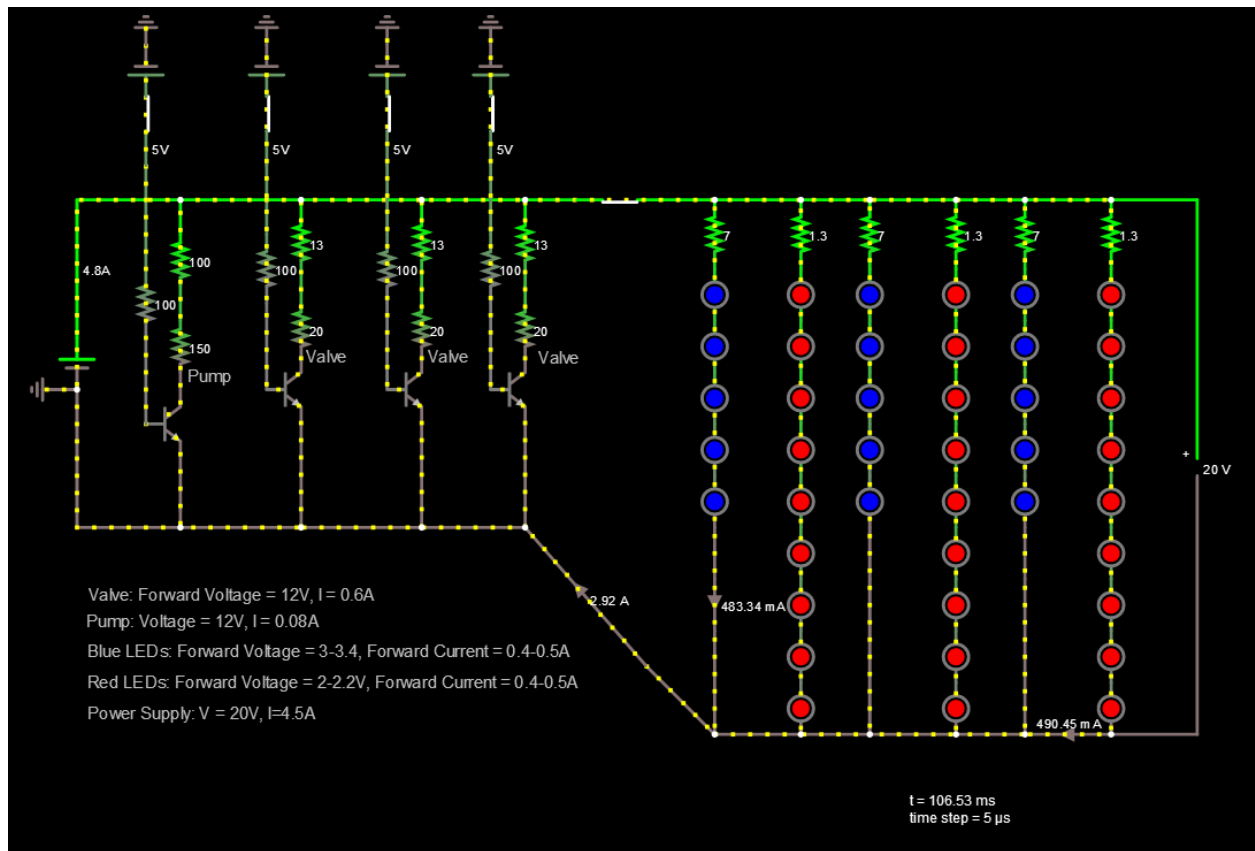
Circuit Design: 12V power supply (Pump and Valves)

16+-32+2%0Aw+448+304+304+304+0%0Aw+304+0+448+0+0%0Ar+272+32+272+208+0+100%0Ax+313+152+354+155+4+16+Pump%0Ar+416+32+416+208+0+100%0Ar+560+32+560+208+0+100%0Ar+704+32+704+208+0+100%0At+704+208+736+208+0+1+0.682510175776758+0.73854137731201+100%0Aw+704+-32+704+32+0%0As+704+-96+704+-64+0+0+false%0Av+704+-144+704+-96+0+0+40+5+0+0+0.5%0Ag+704+-144+704+-160+0%0Aw+704+-64+704+-32+2%0Ax+744+151+781+154+4+16+Valve%0Ax+219+372+485+375+4+16+Valve:%5CsForward%5CsVoltage%5Cs%5Cq%5Cs12V,%5Csl%5Cs%5Cq%5Cs0.6A%0Ax+217+397+433+400+4+16+Pump:%5CsVoltage%5Cs%5Cq%5Cs12V,%5Csl%5Cs%5Cq%5Cs0.08A%0Ax+218+424+667+427+4+16+Blue%5CsLEDs:%5CsForward%5CsVoltage%5Cs%5Cq%5Cs3-3.4,%5CsForward%5CsCurrent%5Cs%5Cq%5Cs0.4-0.5A%0Ax+218+453+674+456+4+16+Red%5CsLEDs:%5CsForward%5CsVoltage%5Cs%5Cq%5Cs2-2.2V,%5CsForward%5CsCurrent%5Cs%5Cq%5Cs0.4-0.5A%0Ax+218+346+417+349+4+16+Power%5CsSupply:%5CsV%5Cs%5Cq%5Cs12V,%5Csl%5Cs%5Cq5A%0Aw+304+224+304+304+0%0Ar+448+32+448+128+0+20%0Ar+592+32+592+128+0+20%0Ar+736+32+736+128+0+20%0Ax+599+149+636+152+4+16+Valve%0Ax+456+152+493+155+4+16+Valve%0Ap+144+0+144+304+1+0%0Aw+208+304+144+304+0%0Aw+208+0+144+0+0%0Ad+352+128+352+32+1+0.805904783%0Ad+496+128+496+32+1+0.805904783%0Ad+640+128+640+32+1+0.805904783%0Ad+784+128+784+32+1+0.805904783%0Aw+304+0+304+32+0%0Aw+304+32+352+32+0%0Aw+352+128+304+128+0%0Aw+304+128+304+192+0%0Aw+448+0+448+32+0%0Aw+448+32+496+32+0%0Aw+496+128+448+128+0%0Aw+448+128+448+192+0%0Aw+592+0+592+32+0%0Aw+592+32+640+32+0%0Aw+640+128+592+128+0%0Aw+592+128+592+192+0%0Aw+736+192+736+128+0%0Aw+784+32+736+32+0%0Aw+784+128+736+128+0%0Aw+736+32+736+0+0%0

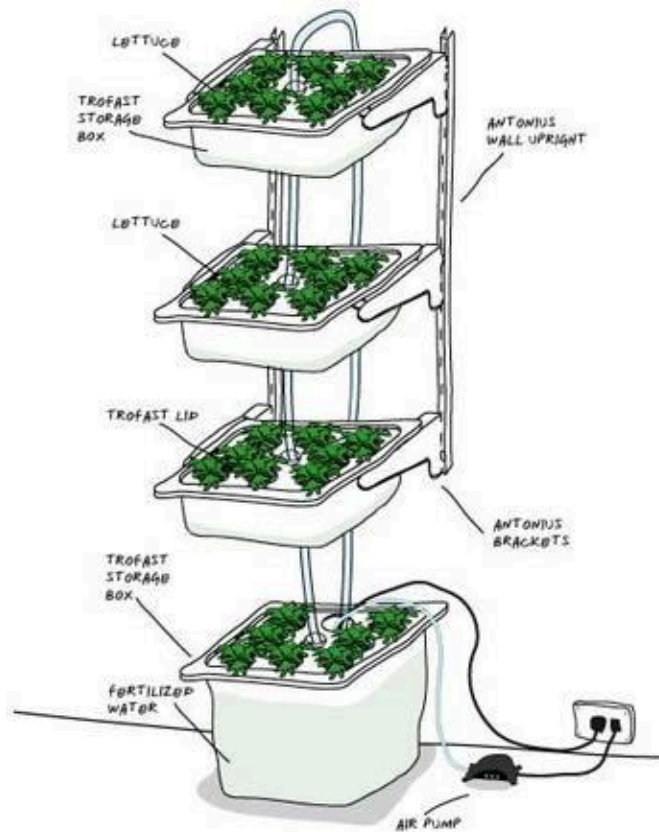
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[0As+384+-96+384+-64+0+0+false%0At+384+176+416+176+0+1+0.6825101757767539+0.7385413773120099+100%0Aw+384+-32+384+32+0%0Av+384+-144+384+-96+0+0+40+5+0+0+0.5%0Ag+384+-144+384+-160+0%0Aw+384+-64+384+-32+2%0Aw+416+304+304+304+0%0Aw+304+0+416+0+0%0Ar+272+32+272+208+0+100%0Aw+304+160+304+192+0%0Ax+311+169+352+172+4+16+Pump%0Ar+384+32+384+176+0+100%0Ar+496+32+496+176+0+100%0Ar+592+32+592+176+0+100%0At+592+176+624+176+0+1+0.6825101757767577+0.7385413773120102+100%0Aw+592+-32+592+32+0%0As+592+-96+592+-64+0+0+false%0Av+592+-144+592+-96+0+0+40+5+0+0+0.5%0Ag+592+-144+592+-160+0%0Aw+592+-64+592+-32+2%0Aw+624+0+672+0+0%0Aw+800+304+800+352+0%0Aw+944+304+944+352+0%0Aw+1088+304+1088+352+0%0A162+800+64+800+112+1+3.4+0+0+1+0.5%0A162+800+112+800+160+1+3.4+0+0+1+0.5%0A162+800+160+800+208+1+3.4+0+0+1+0.5%0A162+800+256+800+304+1+3.4+0+0+1+0.5%0A162+800+256+1+3.4+0+0+1+0.5%0Ar+800+0+800+64+0+7%0Ar+880+0+880+64+0+1.3%0Aw+880+0+800+0+0%0A162+880+64+880+112+1+2.2+1+0+0+0.5%0A162+880+160+880+208+1+2.2+1+0+0+0.5%0A162+880+112+880+160+1+2.2+1+0+0+0.5%0A162+880+304+880+352+1+2.2+1+0+0+0.5%0A162+880+352+880+400+1+2.2+1+0+0+0.5%0A162+880+256+880+304+1+2.2+1+0+0+0.5%0A162+880+208+880+256+1+2.2+1+0+0+0.5%0A162+880+400+880+448+1+2.2+1+0+0+0.5%0Aw+1024+0+944+0+0%0Ar+1024+0+1024+64+0+1.3%0Ar+944+0+944+64+0+7%0A162+944+208+944+256+1+3.4+0+0+1+0.5%0A162+944+256+944+304+1+3.4+0+0+1+0.5%0A162+944+160+944+208+1+3.4+0+0+1+0.5%0A162+944+112+944+160+1+3.4+0+0+1+0.5%0A162+944+64+944+112+1+3.4+0+0+1+0.5%0Aw+880+0+944+0+0%0Aw+1024+0+1088+0+0%0A162+1088+64+1088+112+1+3.4+0+0+1+0.5%0A162+1088+112+1088+160+1+3.4+0+0+1+0.5%0A162+1088+160+1088+208+1+3.4+0+0+1+0.5%0A162+1088+256+1088+304+1+3.4+0+0+1+0.5%0A162+1088+208+1088+256+1+3.4+0+0+1+0.5%0Ar+1088+0+1088+64+0+7%0Ar+1168+0+1168+64+0+1.3%0Aw+1168+0+1088+0+0%0A162+880+448+880+496+1+2.2+1+0+0+0.5%0A162+1168+448+1168+496+1+2.2+1+0+0+0.5%0A162+1168+400+1168+448+1+2.2+1+0+0+0.5%0A162+1168+208+1168+256+1+2.2+1+0+0+0.5%0A162+1168+256+1168+304+1+2.2+1+0+0+0.5%0A162+1168+352+1168+400+1+2.2+1+0+0+0.5%0A162+1168+304+1168+352+1+2.2+1+0+0+0.5%0A162+1168+112+1168+160+1+2.2+1+0+0+0.5%0A162+1168+160+1168+208+1+2.2+1+0+0+0.5%0A162+1168+64+1168+112+1+2.2+1+0+0+0.5%0A162+1024+448+1024+496+1+2.2+1+0+0+0.5%0A162+1024+400+1024+448+1+2.2+1+0+0+0.5%0A162+1024+208+1024+256+1+2.2+1+0+0+0.5%0A162+1024+256+1024+304+1+2.2+1+0+0+0.5%0A162+1024+352+1024+400+1+2.2+1+0+0+0.5%0A162+1024+304+1024+352+1+2.2+1+0+0+0.5%0A162+1024+112+1024+160+1+2.2+1+0+0+0.5%0A162+1024+160+1024+208+1+2.2+1+0+0+0.5%0A162+1024+64+1024+112+1+2.2+1+0+0+0.5%0Aw+1088+352+1088+496+0%0Aw+1088+496+1024+496+0%0Aw+944+352+944+496+0%0Aw+944+496+1024+496+0%0Aw+944+496+880+496+0%0Aw+880+496+800+496+0%0Aw+800+400+800+496+0%0Aw+752+0+800+0+0%0Ap+1248+0+1248+496+1+0%0Aw+1248+496+1168+496+0%0Aw+1248+0+1168+0+0%0Aw+736+432+800+496+0%0As+752+0+672+0+0+false%0A370+800+352+800+400+1+0%0A370+736+432+624+304+1+0%0Ax+637+152+674+155+4+16+Valve%0A370+1168+496+1088+496+1+0%0Ax+219+372+485+375+4+16+Valve:%5CsForward%5CsVoltage%5Cs%5Cq%5Cs12V,%5Csl%5Cs%5Cq%5Cs0.6A%0Ax+217+397+433+400+4+16+Pump:%5CsVoltage%5Cs%5Cq%5Cs12V,%5Csl%5Cs%5Cq%5Cs0.08A%0Ax+218+424+667+427+4+16+Blue%5CsLEDs:%5CsForward%5CsVoltage%5Cs%5Cq%5Cs3-3.4,%5CsForward%5CsCurrent%5Cs%5Cq%5Cs0.4-0.5A%0Ax+218+453+674+456+4+16+Red%5CsLEDs:%5CsForward%5CsVoltage%5Cs%5Cq%5Cs2-2.2V,%5CsForward%5CsCurrent%5Cs%5Cq%5Cs0.4-0.5A%0Ax+218+482+430+485+4+16+Power%5CsSupply:%5CsV%5Cs%5Cq%5Cs20V,%5Csl%5Csq%5Cs4.5A%0Aw+304+224+304+288+0%0Ar+416+0+416+160+0+20%0Ar+528+0+528+160+0+20%0Ar+624+0+624+160+0+20%0Ax+534+151+571+154+4+16+Valve%0Ax+421+151+458+154+4+16+Valve%0A](#)



Setup Designs



<http://www.urbangardensweb.com/2013/06/01/how-to-build-indoor-hydroponic-gardens-using-ikea-storage-boxes/>

Pseud Code

Check all moisture values

If the soil is dry

- Turn on pump
- Open valves to dry soil (only one level at a time)