Lights: *Full spectrum covers all types of lights for plants.

https://migrolight.com/blogs/grow-light-news/how-high-to-hang-your-grow-light-for-maximum-yield

Light/Day cycle (Limited by plant type) 16Hr -12Hr -8Hr

Enclosure:

The dimensions of the enclosure (height (at least 45cm), width (at least 61cm), depth (Plant dimension)) (m) – Finial

- Materials * things in the enclosure will help retain heat (Pots, soil, plant).
- Frame type?
- Insulation - Mylar (stretched polyester film) – reflective Insulation
- Airflow Ventilation (running-when necessary, hot air rises (exhaust here), New air near plant)
- Controlling ventilation (Fan turns on if it is too hot, fan turns off if it is too cold)
- Type of wires

Design Considerations: LxWxH *Material

Wires: Gauge, Length of wires wire coloring, Connector mounts? Wire management!

Lights: USB- Argument (The distance from the plant for optimal growth) *(Controller for)

Sensors: How will they be installed

Temperature – 10-15 cm above plant

Humidity – Can't be facing lights (consider facing downwards)

Moister – into soil (not past line!)

Fan: Placement of fans (intake near plants, exhaust near top) *Relay attachment

Intake – Fresh air and blows it across plants

Exhaust – blows hot air and humidity out

Pump-Water to be distributed (volume of container), how will tube be placed

*Considerations (Heating pad, PTC Heater(150W@12v,12amps)?)

For plants (Temperature/Humidity/Moisture sensors):

Water plants:

1. **Seedlings or Young Plants**:
   Check every 10-15 minutes. shallow roots and are more sensitive to drying out. Higher moister!
2. **Mature Plants in the Vegetative Stage**:
   Check every 30 minutes to an hour. As roots grow deeper, the plant can access more water, reducing the need for constant checks. Moderate moister!
3. **For Flowering Plants**:
   Every 30 minutes to 1 hour or adjust based on the plant's sensitivity. Flowering stages may need more moisture stability!

TYPE Soil (all-purpose potting mix)

- Type of growable plants in enclosure (Limit size of enclosure)
- VPD for plants (Limited by growth cycle) – parameter

(tomatoes, peppers, or flowering plants)

- Seedling Stage: Lower VPD
- Vegetative Stage: Moderate VPD is optimal
- Flowering Stage: Higher VPD can improve bud or fruit quality in flowering plants

1. **Figure out the SVP**
   - SVP = 610.78 x e^(T / (T +237.3) x 17.2694)
     - T is in degrees Celsius
     - The result, SVP, is in pascals (divide by 1000 to get kPa)
     - e is a mathematical constant called Euler's Number, approximately equal to 2.71828.
2. **Calculate the VPD**
   - SVP x (1 – RH/100) = VPD

$$\text{Evaporation Rate}(E) = k \times A \times \left(1 - \frac{\text{RH}}{100}\right) \times (T - T_{dew})$$

where:

- E is the evaporation rate in liters per hour.
- k is an evaporation coefficient, typically around 0.1 to 0.2 for still air and up to 0.5 for strong airflow. (For an enclosure with moderate airflow, use ~0.15).
- A is the surface area of the soil (m^2).
- RH is the relative humidity in the enclosure (0-100%).
- T is the air temperature in the enclosure (°C).
- T_{dew} is the dew point temperature, calculated as a function of RH and air temperature.

Useful

https://extension.okstate.edu/fact-sheets/understanding-soil-water-content-and-thresholds-for-irrigation-management.html#:~:text=Permanent%20wilting%20point%20(PWP)%20is,plant%20roots%20to%20extract%20it.

Temperature:

https://herbals.co.nz/blogs/spectrum-led-grow-lights/how-temperature-affects-plant-growth#:~:text=As%20a%20general%20rule%20of,degrees%2C%20problems%20can%20quickly%20occur.

https://www.aquagardening.com.au/learn/ideal-temperature-and-light-for-plants/#:~:text=Plants%20grow%20well%20in%20moderate,22%C2%B0%2D26%C2%B0C.

https://www.sanas.com/download/18.1715bfaf1530dc5636613aeb/1459420579402/01337%20-%20Calculation.pdf

Heat in enclosure (most electrical power in an enclosure will convert to heat.)

Hysteresis? – Time delays to prevent. *Time delay intervals (5-10ms)

Desired internal temperature of enclosure:

PH=A×k×ΔT (PH a range of 20°C - 25°C or whatever we can get out)

- Seedling Stage: 18°C-24°C (64°F-75°F)
- Vegetative Stage: 20°C-26°C (68°F-78°F)
- Flowering Stage: 20°C-28°C (68°F-82°F)

Calibration test:

• Ice **Bath (0°C)**:

- Fill a container with crushed ice and a little water to create an ice bath. This should reach a stable temperature of 0°C.
- Insert the PT100 sensor into the ice water, making sure it doesn't touch the container walls, and let it stabilize for a few minutes.
- Measure the resistance or voltage (if using a Wheatstone bridge) corresponding to 0°C.

• Boiling **Water (100°C at Sea Level)**:

- Boil a pot of water and place the PT100 sensor in the water, avoiding contact with the container walls.
- Boiling water reaches around 100°C
- Measure the resistance or output voltage corresponding to 100°C.

• Room **Temperature (~20-25°C)** (Optional):

- thermometer to check room temperature. Measure the PT100's resistance at this ambient temperature for an additional calibration point if available.

Humidity sensor:

Calibration test:

• Low **Humidity Reference (~10-20% RH)**:

- Create a low-humidity environment by placing the sensor in a sealed bag with **dry rice** or **silica gel packets** (often found in packaging).
- Leave the sensor in this environment for about 15–30 minutes to let it stabilize. This won't reach 0% RH exactly, but it will give you a repeatable low humidity point around 10-20% RH.

• High **Humidity Reference (75% RH)**:

- Use a saturated salt solution. Dissolve **table salt** (sodium chloride) in a small, shallow container of water until it no longer dissolves, and you see undissolved salt at the bottom.
- Place the container and sensor in a sealed plastic container or large zip-lock bag and let it sit for several hours. This should create a stable environment of around 75% RH at room temperature.

VPD:

https://pulsegrow.com/blogs/learn/vpd?srsltid=AfmBOorSSYhbycFWfy5A9qgju2ixNzs0szY2wOCrmBSAFGlglVT4jLdl#calculate – Everything about VPD

Table 1 All Plants grow cycle VDP

Temperature (°C)	Saturation Vapor Pressure (kPa)	VPD = 0.6 kPa (RH %)	VPD = 1.5 kPa (RH %)
20	2.34	74.4	35.9
21	2.49	76.4	39.2
22	2.65	78.2	42.5
23	2.84	80.1	45.9
24	3.02	81.8	49.3
25	3.17	80.9	52.7
26	3.37	83.4	55.5
27	3.58	84.9	58.7
28	3.78	86.3	62.0
29	3.99	87.6	65.0
30	4.24	85.9	64.5

Table 2 Vegetative Cycle VDP

Temperature (°C)	Saturation Vapor Pressure (kPa)	VPD = 0.8 kPa (RH %)	VPD = 1.2 kPa (RH %)
20	2.34	65.3	42.7
21	2.49	67.0	44.8
22	2.65	68.6	46.6
23	2.84	70.5	48.9
24	3.02	72.4	51.1
25	3.17	74.0	52.9
26	3.37	75.8	55.0
27	3.58	77.4	57.1
28	3.78	78.9	59.4
29	3.99	80.2	61.4
30	4.24	79.5	60.4