Information Gathering:
Phase Change Incubator Example

Its often helpful to keep track of all the questions you want to answer about your project so that you can determine the best method for answering them and make sure that you get all the information that you need. This may be through internet and library research, interviews, patent searches, benchmarking, observational research, or physical testing.

Questions

What is the cost of currently available incubators?
What types of tests are done in an incubator?
What is the temperature required for these tests?
How long do the tests take?
What size should the incubator be?
What power sources are available at the clinics?
What should the capacity of the incubator be?

Currently Available Incubators Benchtop Incubators:

	Chamber Size	Range/Accuracy	Cost
Lab-Line L-C	13" x13" x13"	ambient-65	$770
Lab-Line	7" x10" x8"	ambient-40	$335
	11" x11" x11"	ambient-60	$440
	13" x16" x15"	ambient-45	$410
Thermolyne	8" x10" x6.75"	30-60 +/-0.6	$440
Boekel	12" x11" x10"	ambient-60	$392
Precision	14" x13" x13"	ambient-65 +/-0.3	$1295
Precision Economy	13" x14" x13"	ambient-65 +/-0.5	$595

Features of Incubators:

Temperature Control Gravity Flow Convection or Forced Convection
Carbon Dioxide Control Water Jacketed (to maintain humidity)
Power Indicator, Heat Indicator, Back-up Indicator Capacity

Interview with Janet Bertolini of the MIT Medical Department:

What tests require incubation?
- Bacterial cultures such as salmonella, shagella and eurocinea STD tests such as ghonnorea (which also require carbon dioxide) Elisa tests and Western blots for AIDS diagnosis antibody tests

What size should the internal chamber be?
- petri dish-sized diameter, height depends on lab

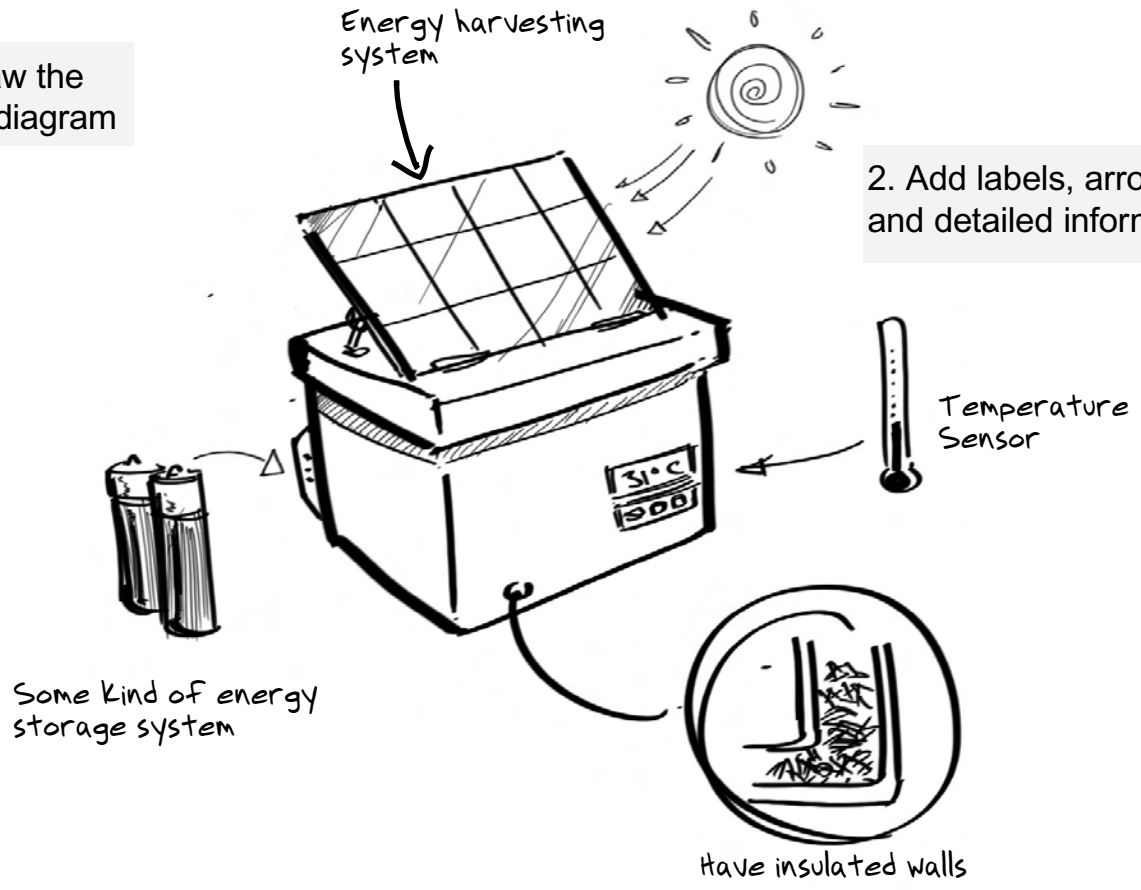
What temperatures are required?
- mostly human temperatures (36 - 38)

Problem Framing:
Phase Change Incubator Example

A good way to communicate different problem framings is to make simple, annotated sketches that show the general approach rather than emphasizing specific details. This can help provide additional perspectives on the problem and its potential solutions.

Problem Framing 1:
Providing Alternative Energy for Existing Incubators

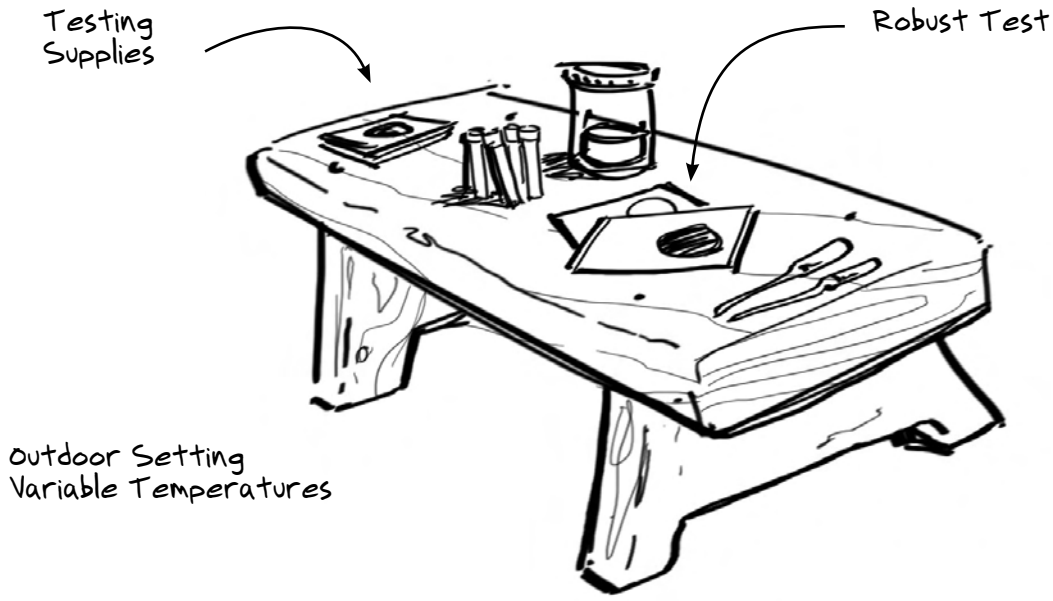
1. Draw the main diagram



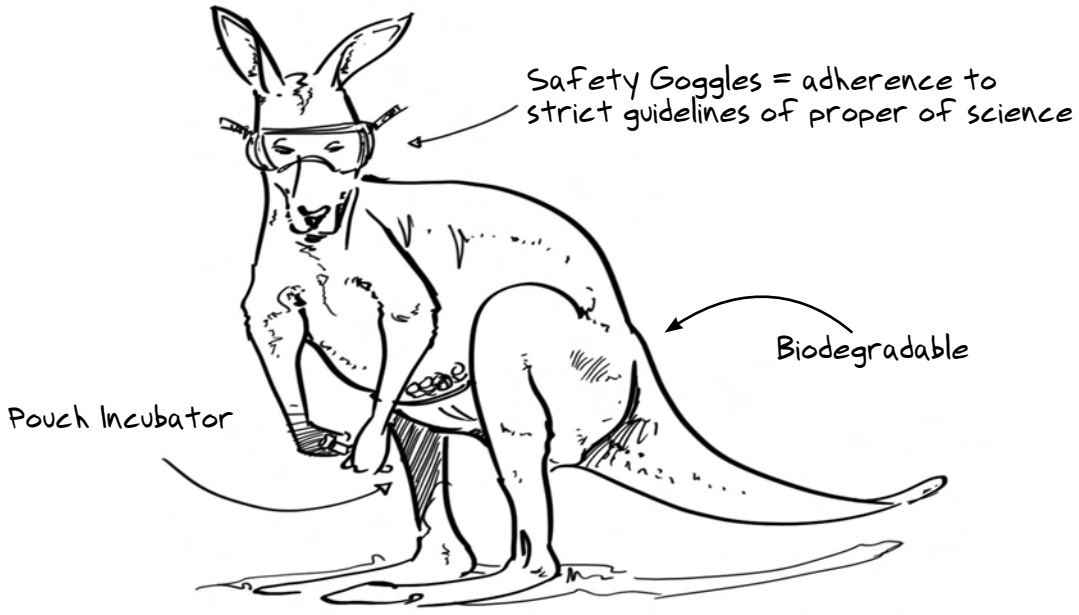
2. Add labels, arrows and detailed information

3. Write brief explanation notes

Problem Framing 2:
Develop Tests That Don't Require Constant Temperatures



Problem Framing 3:
Keep the Samples Warm Using Other Means



Problem Statement:
Phase Change Incubator Example

We will build a device to allow nurses, doctors and/or technicians in rural medical clinics in developing countries to grow bacterial samples for the purpose of analysis or diagnostics. The device should be inexpensive, easy to use and be compatible with the existing testing equipment.

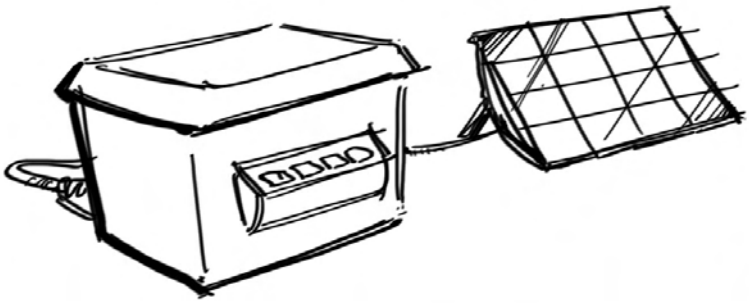
Design Specifications:
Phase Change Incubator Example

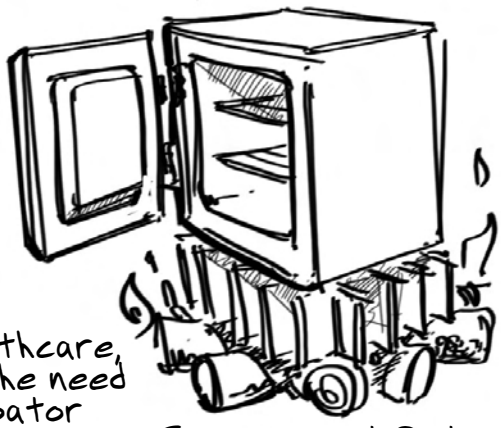
User Need	Design Specification	Acceptable Value	Ideal Value
Portable	weight	< 3 kg	< 2 kg
	size	< 18 x 15 x 15	< 14 x 12 x 10
Provides a constant temperature	internal temperature	37°C +/- 1°C	37°C +/- 0.5°C
Safety	non-toxic materials	< irritant	restorative
	fire resistance	fire resistant materials	fire retardant materials
Affordable	cost	< $500	< $100
Easy to Use	time to prepare incubator for use	< 30 minutes	< 10 minutes
	frequency of monitoring	< 3 times a day	< 1 time a day
Flexibility	ability to accomodate different sample form factors	test tubes & petri dishes	test tubes, petri dishes & 100ml bottles

Idea Generation:
Phase Change Incubator Example

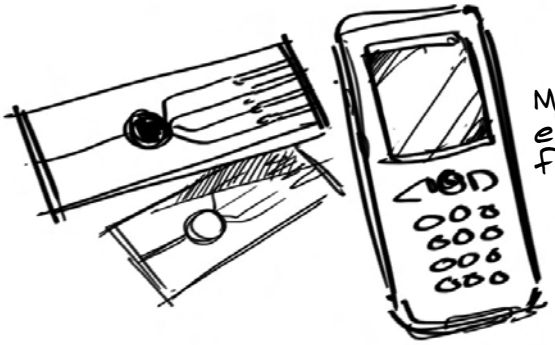
Sketches/Sticky Notes (group brainstorm)

Writing down ideas in words and images to capture them and share with others.





Fire Powered Fridge



Mobile Healthcare, eliminate the need for a incubator

Change the System

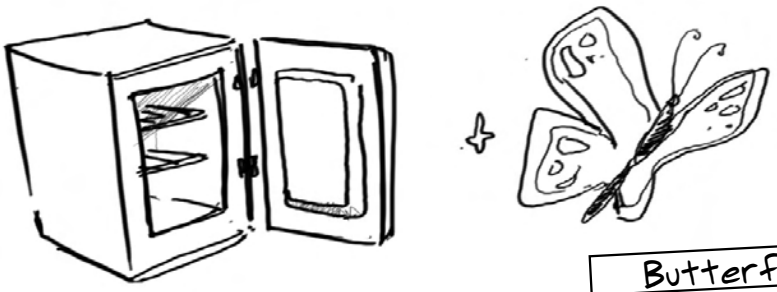
TIMING

FRICTION GENERATOR

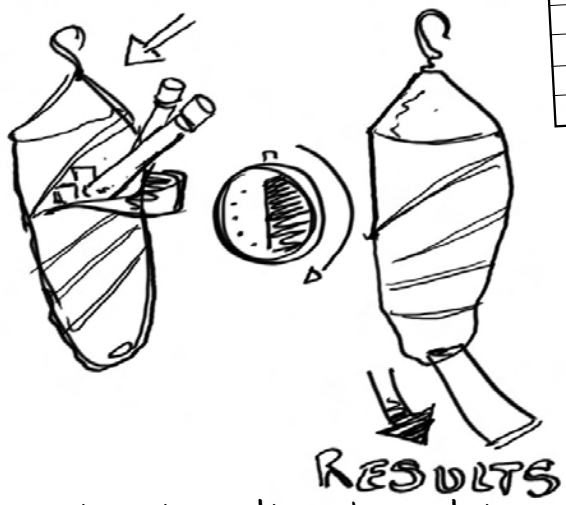
Idea Generation:
Phase Change Incubator Example

Bisociation

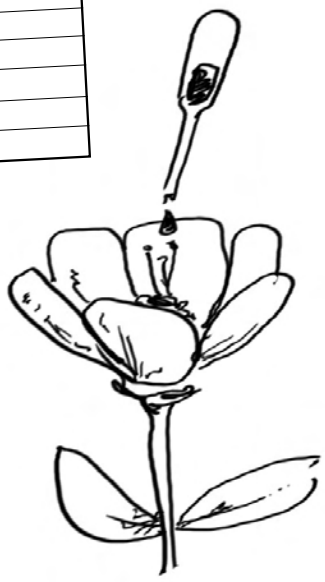
Incubators and Butterflies



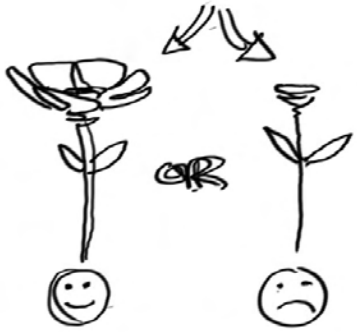
Butterflies:
Cocoon
Nectar
Flight
....



Prints out results 12 hours later

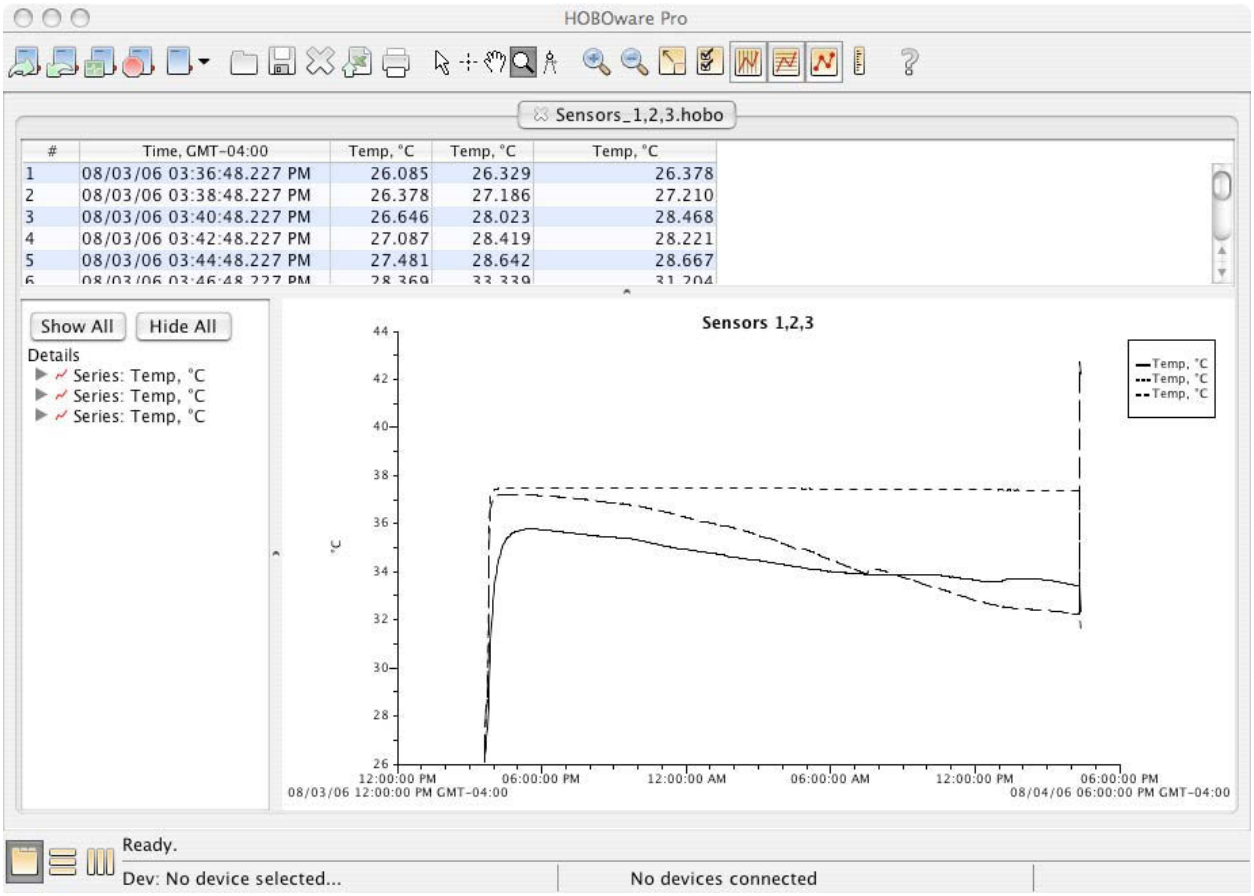


Slow then fast
- Caterpiller then butterfly
- slow prep, fast test



Genetic alteration to flowers, their reaction is the test.

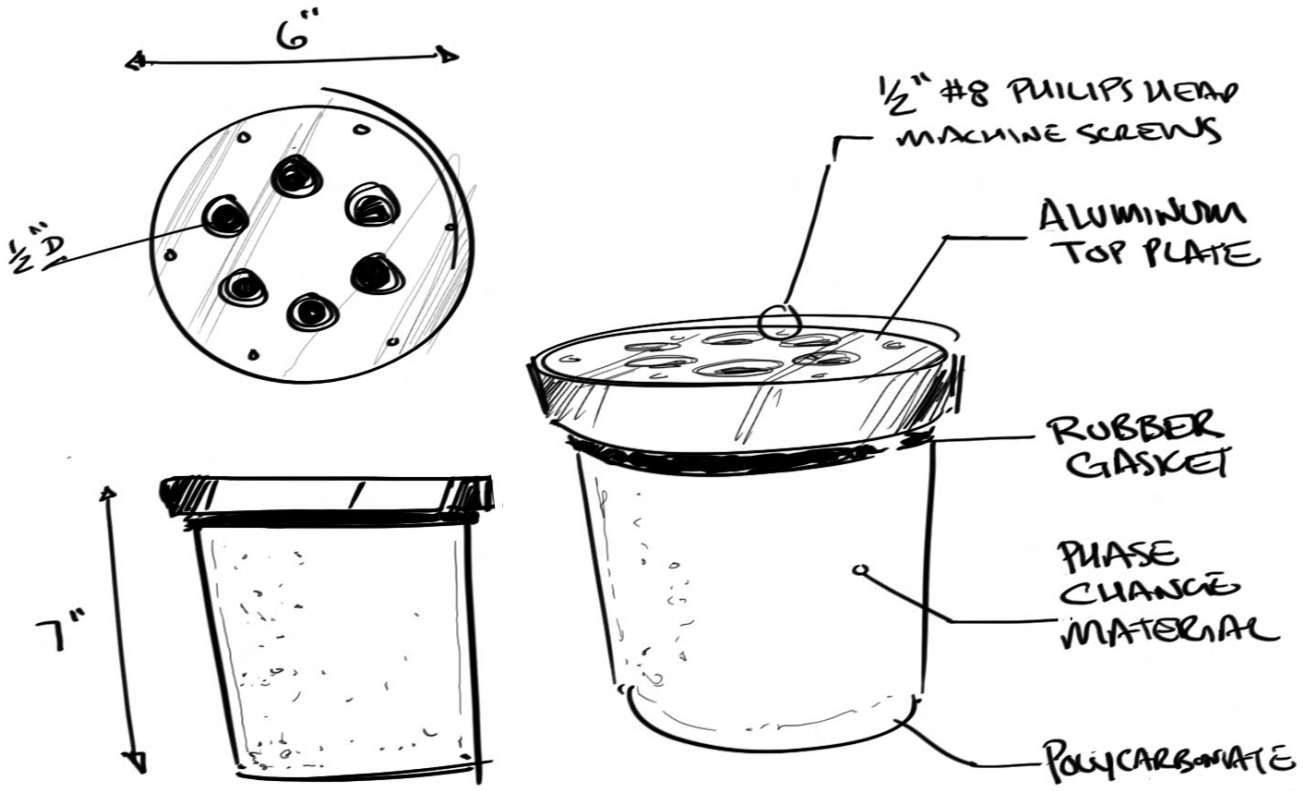
Analysis & Experimentation
Phase Change Incubator Example



Concept Evaluation:
Phase Change Incubator Example

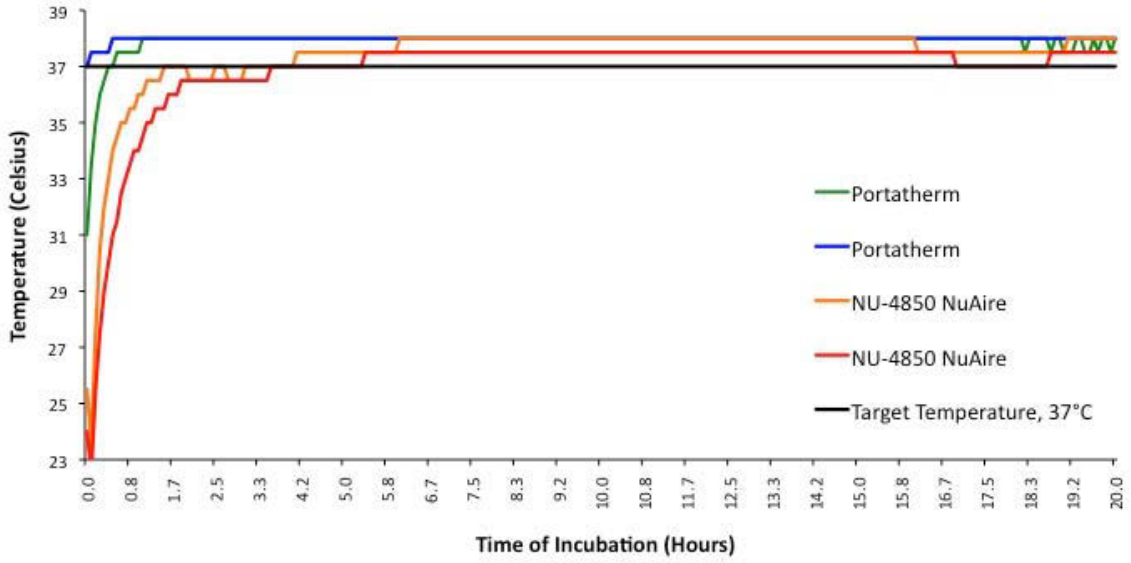
	Datum	Option 1	Option 2	Option 3
Evaluation Criteria	Battery-Operated	Solar	Phase-change	Water Bath
cost	0	+	+	+
reliability	0	-	+	0
accuracy (x2)	0	-	0	-
maintenance	0	0	+	+
safety	0	0	0	0
ease of use	0	-	-	-
Total	0	-3	+2	-1

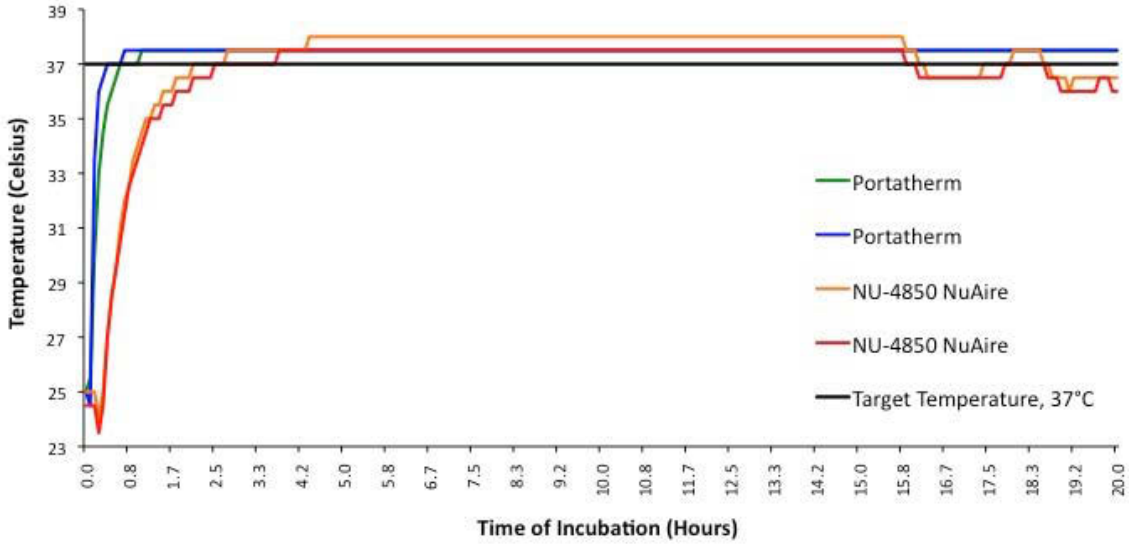
Detailed Design:
Phase Change Incubator Example



Testing & Evaluation:
Phase Change Incubator Example

Results of comparative testing with conventional incubators





EC.720J / 2.722J D-Lab II: Design

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