1) Design, run and analysis

The definition and measurement of the response variable

The response variable in this particular experiment was the **time** each candle takes to burn out naturally. I measured the time as the difference between the moment when the candle has been lighted and the moment when it burned out.

The definition of a run

The experiment was sixteen (16) runs: sixteen candles. They were divided in two different groups:

Frozen (8)		Room Temperature (8)	
With Shield (4)	Without Shield (4)	With Shield (4)	Without Shield (4)

Randomization

My idea of randomization was making a standardization of all my raw materials and process: I took randomly all the candles from the bag, I attempted to add the same quantity of "shield" (corn oild) to eight candles and there were no distinction between them when I chose them to enter to the freezer nor when I lighted them. Even the wick of the candle was set in a straight position.

Selection of materials

1) Sixteen (16) regular Shabbat's candles.
2) Corn Oil
3) Two (2) ceramic plates as base of the candles
4) Aluminum cover
5) Lighter
6) Freezer
7) Watch and Stopwatch

Validity

To validate an experiment as an example of duration time, it is required an irrefutable demonstration. Using a big number of runs we could find an approximation to the reality but using just sixteen runs the error could be bigger. Nevertheless, this experiment do shows an important correlation between the factors and I can express some affirmations for this kind of candles and these particular conditions in the analysis.

Logistics

All the runs were carried out on a table, over two plates. The sixteen candles were lighted with a difference of two minutes (Room Temperature plate at 18:16hs and Frozen plate at 18:18). All of them were exposed to the same meteorological conditions in a closed room.

Frozen Conditions	Room Conditions	Shield	Candles
*-15°C (5°F), 3hs	*20°C (68°F) *63% Humidity *No wind	*Shield made of aluminum (100 microns thick) + *5 cc of Corn Oil on the top	Regular Shabbat's candles.

Results of the experiment

	TIME (in minutes)			
	FROZEN		ROOM TEMP	
	shield	no shield	Shield	no shield
	191	149	202	137
	201	150	202	138
	220	160	209	144
	221	165	220	148
Average	03:02		02:55	
Average	03:28	02:36	03:28	02:21

TIME (in minutes)			
SHIELD		NO SHIELD	
frozen	room	frozen	room
191	202	149	137
201	202	150	138
220	209	160	144
221	220	165	148
03:28		02:28	
03:28	03:28	02:36	02:21

2) Identify and list other factors which you could have checked in this experiment

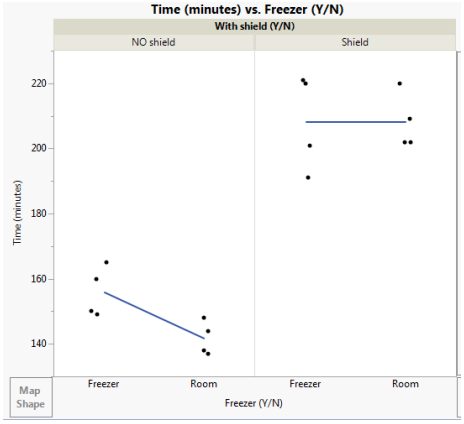
1) Different brands of the same candles
2) Different kind of candles
3) Different colors
4) Different weather conditions
5) Inclination and length of the wick
6) Oxygen
7) Humidity

3) What did you learn for future experiments?

As far as I am concerned, the most important for analyzing and validating results of an experiment is to keep all the quality conditions and to standardize materials and process to be able to aver that the theory that results from the experiment may be applied for future cases when identical conditions are imitated. Little changes may produce big difference in results.

4) Analyze the results

Regarding to the analysis of the results, we can notice that the freezer was not significant on the time the candles took to burn out. However, the shield condition is highly significant. And there is something else: when the candles have shield does not matter if they have been into the freezer or not, but when they have no shield we can appreciate that if they have been into the freezer they all burn out a few minutes later.



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	2	14304.625	7152.31	69.7361
Error	13	1333.313	102.56	Prob > F
C. Total	15	15637.938		<.0001*

Lack Of Fit

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	178.5625	2.531829	70.53	<.0001*
Freezer (Y/N)[Freezer]	3.5625	2.531829	1.41	0.1829
With shield (Y/N)[NO shield]	-29.6875	2.531829	-11.73	<.0001*

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
Freezer (Y/N)	1	1	203.063	1.9799	0.1829
With shield (Y/N)	1	1	14101.563	137.4924	<.0001*

A) Do candles that were in the freezer burn longer than candles at room temperature? NO, but take in consideration if they have shield or not

B) Do candles with a "shield" burn longer than candles without a shield? If so, then how much longer? YES, between 52 and 67 minutes longer

5) Photos

Corn oil

Aluminum

Candles

Candles burning

End of the experiment