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# Disproving (and Re-Proving) the Ideal Gas Law


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# Demonstrating the Ideal Gas Law



## Experiment 1: Charles' Law

| Equipment Needed | |
|---|---|
| Heat Engine/Gas Law Apparatus | Container of hot water |
| PASCO Interface and Data Collection Software | Ice |
| PASCO Temperature Sensor | |

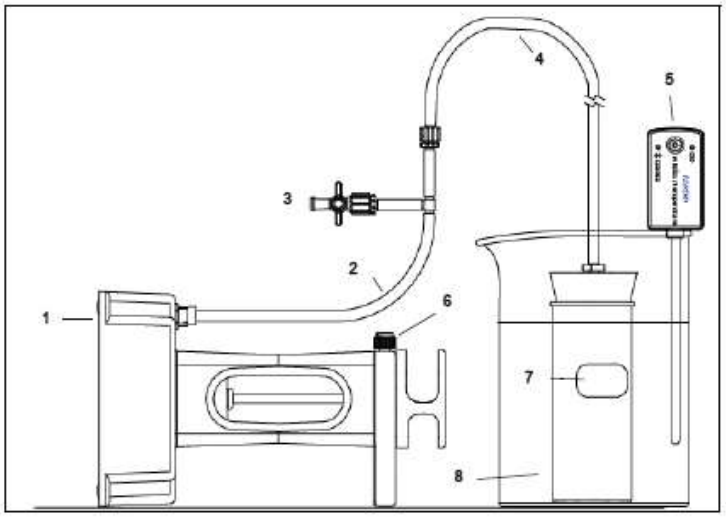
### Introduction

Charles' Law states that at a constant pressure, the volume of a fixed mass or quantity of gas varies directly with the absolute temperature.

$$V = cT$$

In the formula, **V** is volume, **T** is absolute temperature measured in Kelvin, and **c** is a constant.

### Equipment Setup




- Standard PASCO equipment:

  Heat Engine / Gas Law Apparatus TD8572A

- Instructions from the manual for demonstrating Charles' Law, V=cT

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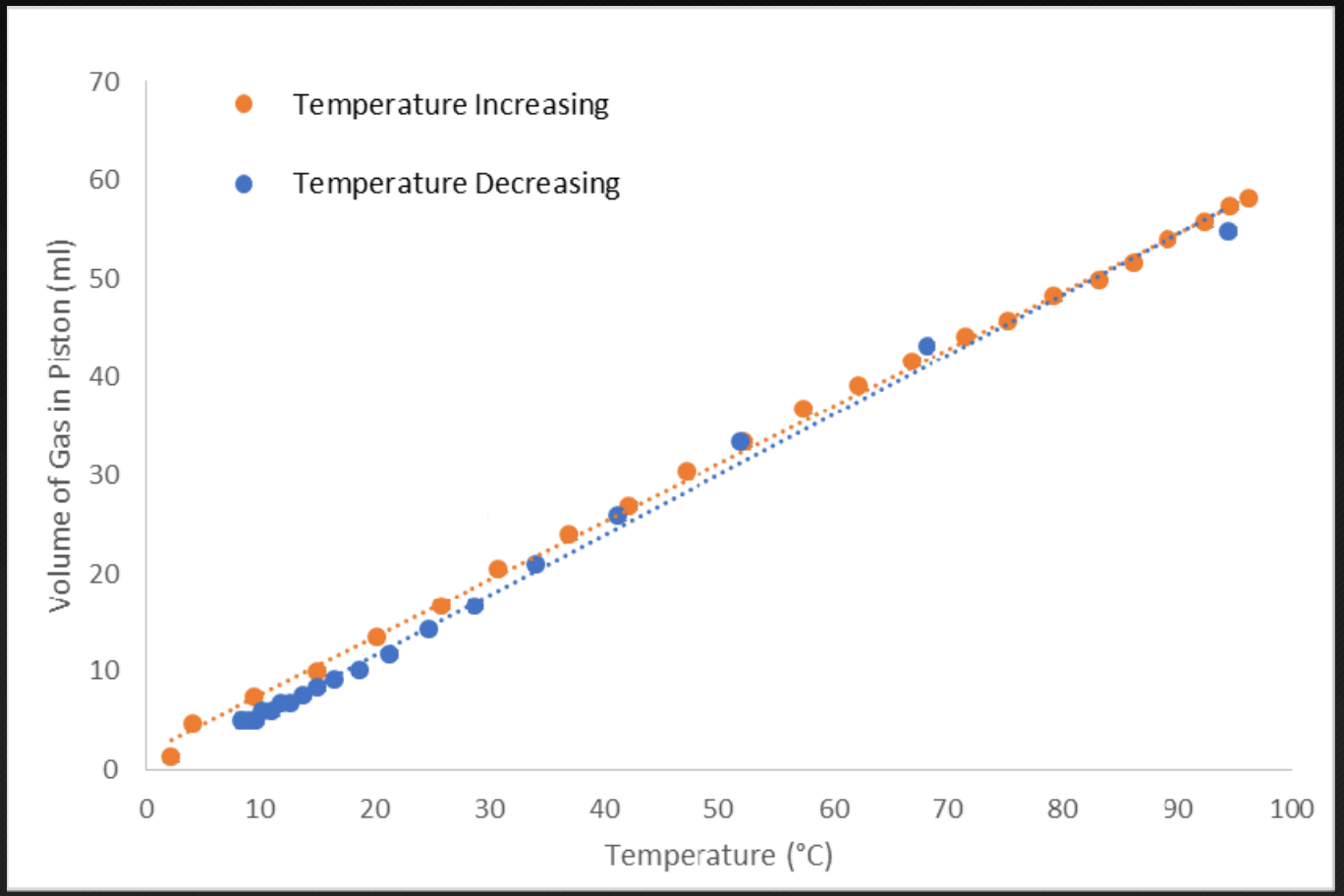
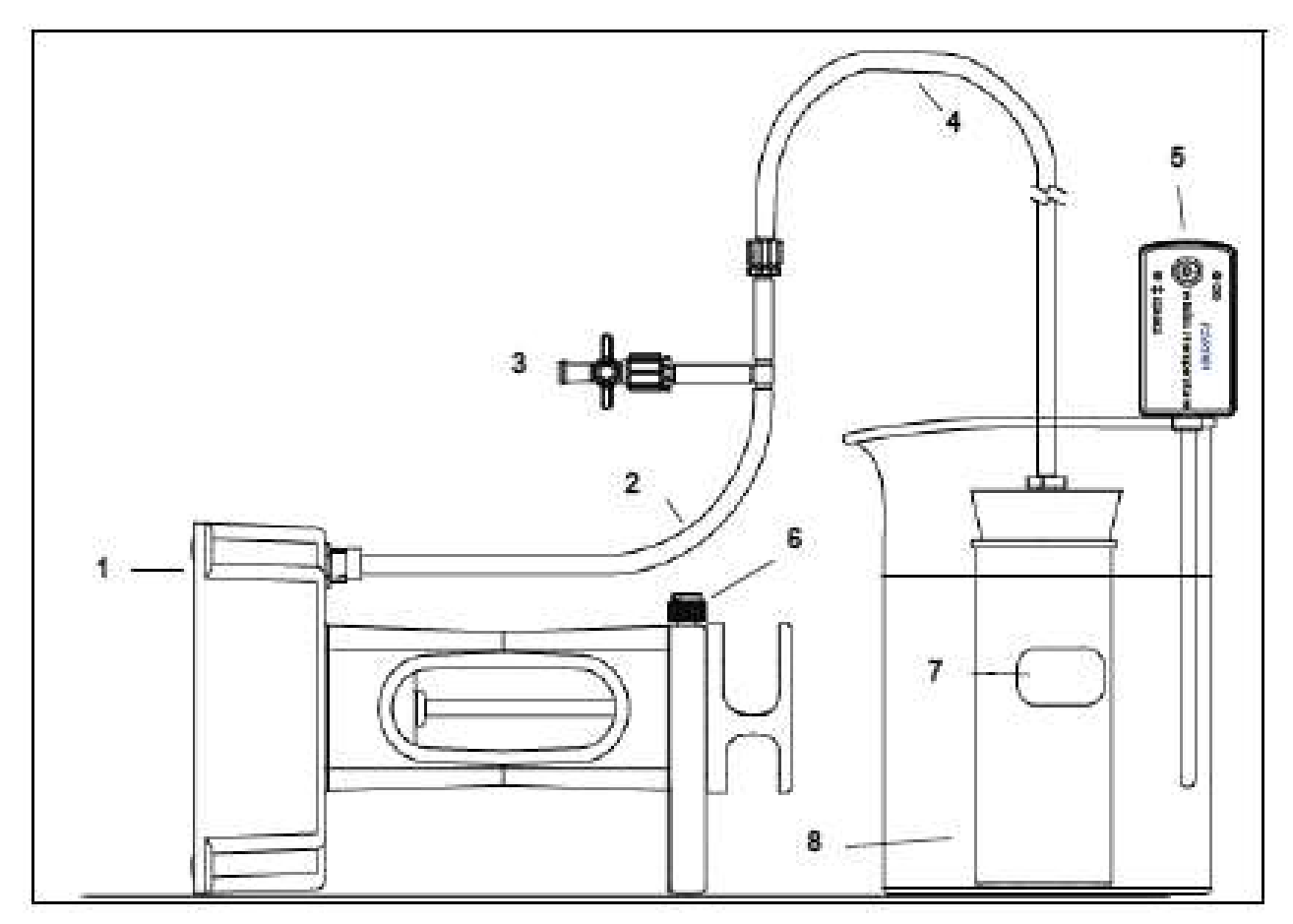
# Linear fit. But a curve would fit better.



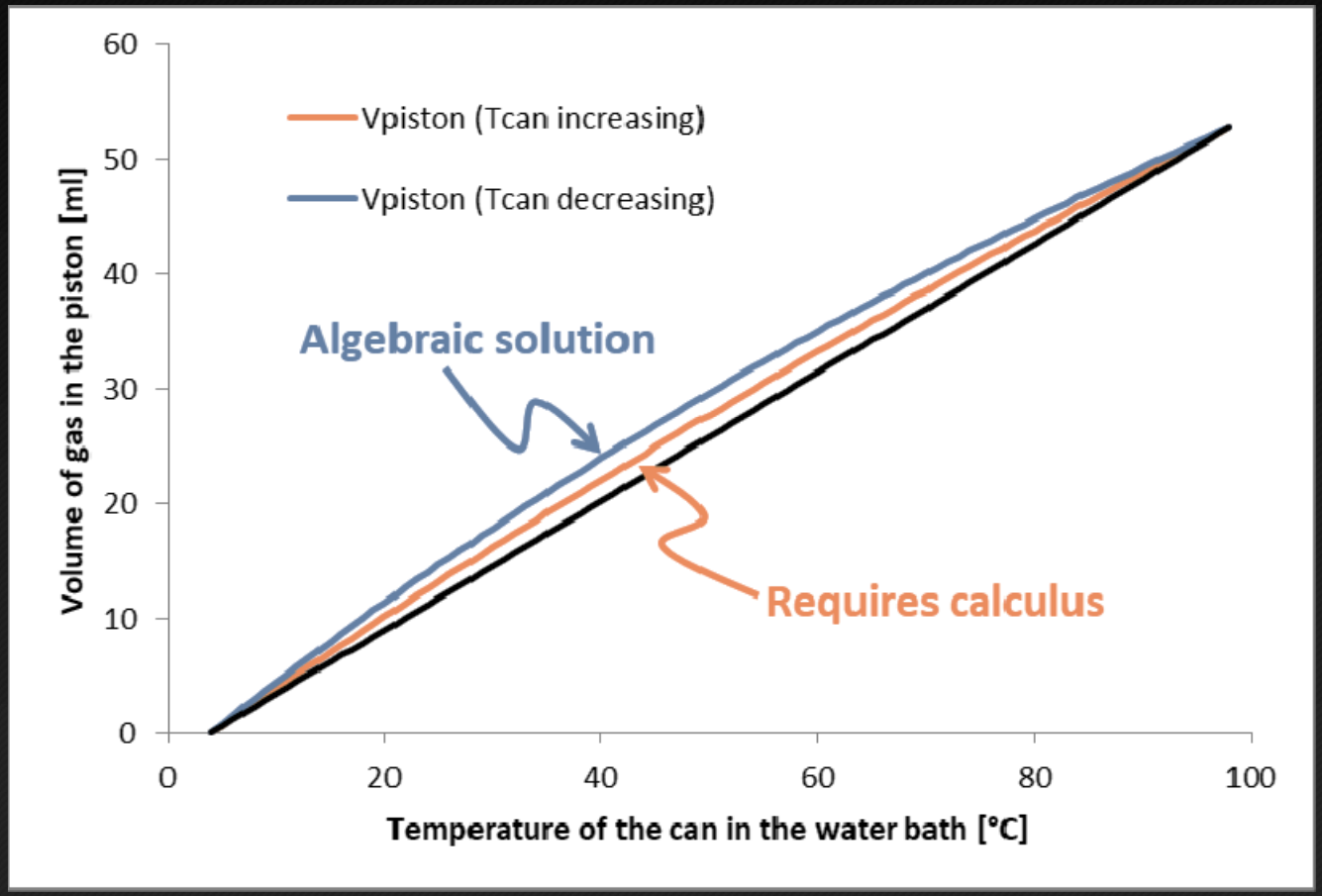
# Is the Ideal Gas Law wrong!?

- This was a good class exercise because:
  - It got them thinking deeply
  - Neither YouTube nor Google was any help
- But they couldn't solve it in 90 minutes. Proposed solutions:
  - Van der Waals forces
  - Phase transitions near 0°C & 100°C
  - Inaccurate measurements

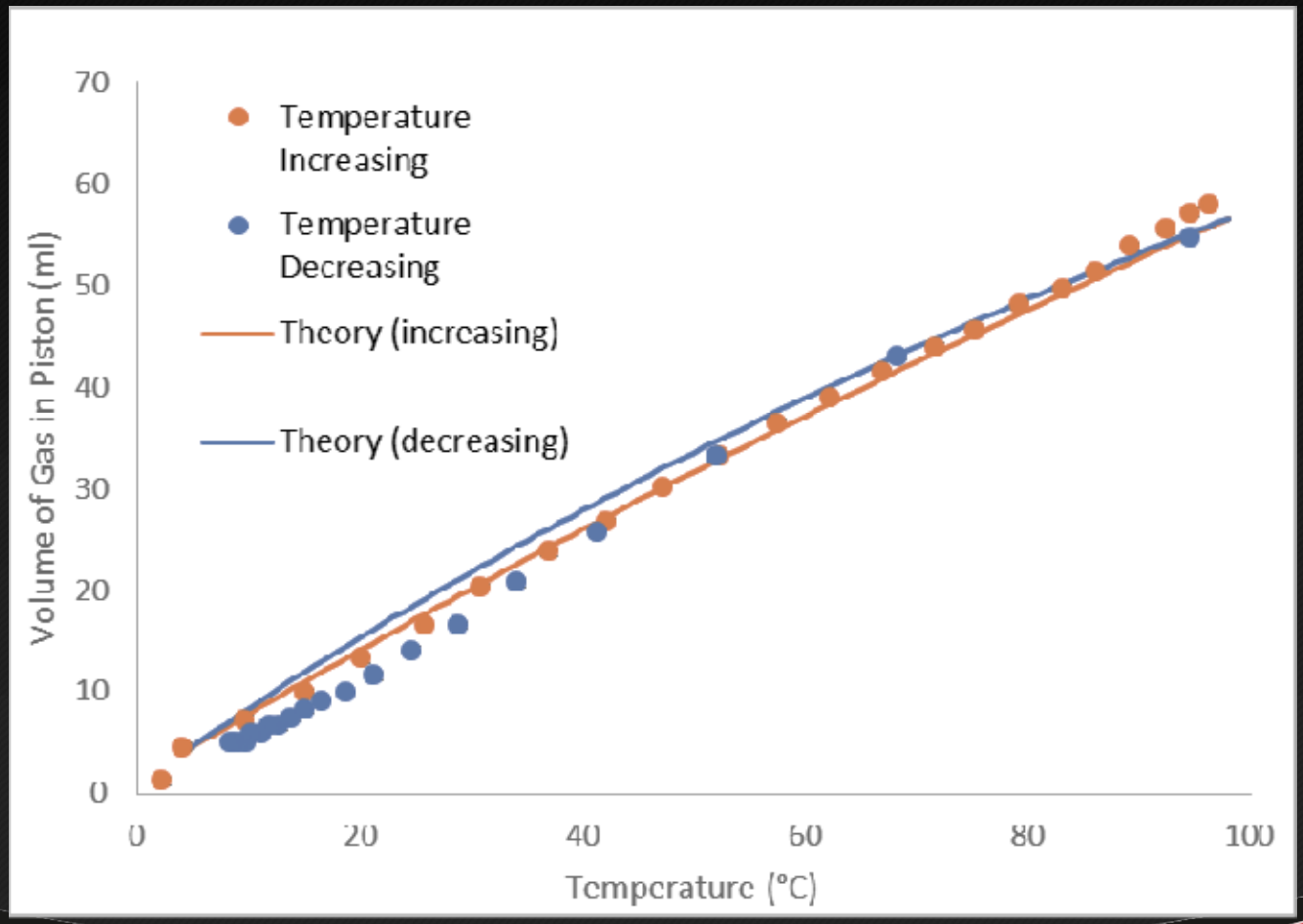
# So why the curve? Look closely.



# Increasing vs Decreasing Temp



# Fits student data fairly well.



# If you try it…

- Get good data
  - Large temperature range (4C – 95 C)
  - Dry air (I kept canisters in frost-free freezer)
  - Keep the canister fully submerged (we used rubber bands across mouth of beaker).
  - Don't start with ice water, but ice-cold water.
  - Double bath for decreasing temperature?
- Guide the analysis
  - Emphasize that they just need to apply the things they have learned in class. (No van der Waals forces required!)
  - Limit to ~45 minutes of class time?