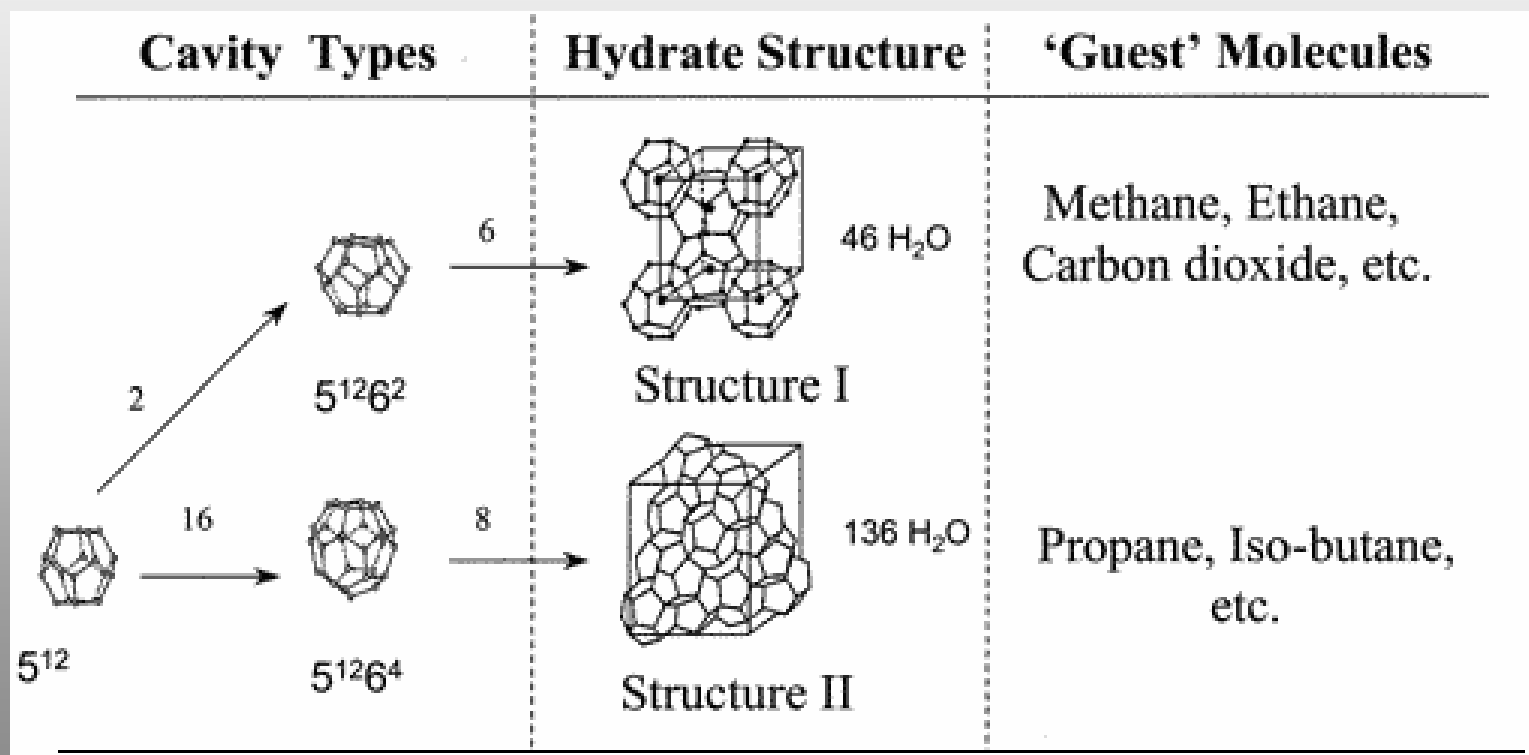


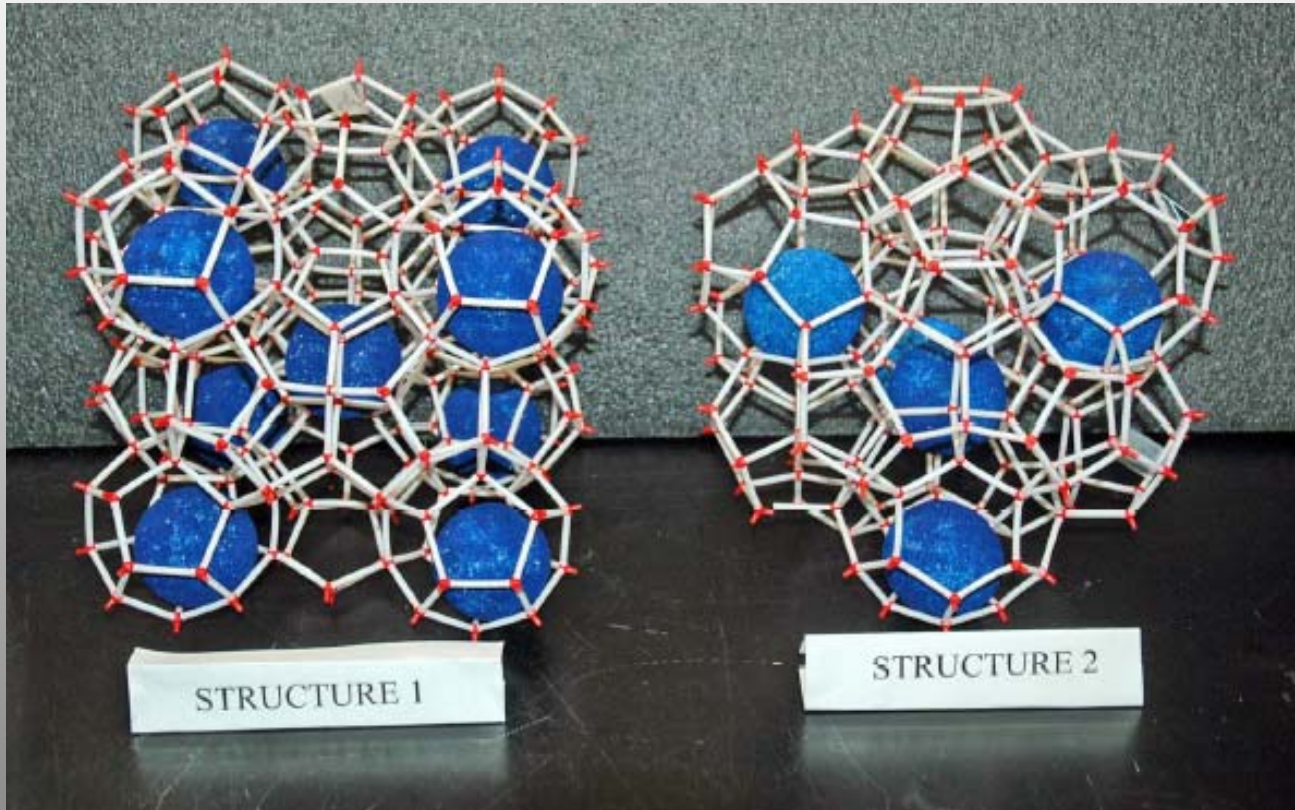
**GAS HYDRATE CLATHRATES  
EXPERIMENT FOR HIGH  
SCHOOL AND  
UNDERGRADUATE  
LABORATORIES**

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- Gas hydrates also known as clathrate hydrates are crystalline compounds with structures consisting of a lattice of water molecules hydrogen bonded together, which encage molecules of smaller-diameter gases (Stern, L.A.; *Science* 1996,273,1843-1848)

# Structure 1 and Structure 2 Clathrate





# Why study gas hydrate clathrates?

- Interesting problem on thermodynamics and bonding.
- There is a large quantity of methane clathrate on the ocean floor  $10^{12}$  kg (Kvenvolden ,K.A. *Ann. N. Acad. Sci.* 1994, **715**, 232-246)
- *Possible energy source and transport medium.*

Animals have even learned  
how to “eat” hydrates for  
energy



# Why propane?

- Propane is inexpensive and easily obtainable.
- Propane gas tanks have a relatively low pressure (115 psi)
- Propane hydrate clathrate is stable above 0 °C @ 1 atm.

# Procedure

- Making ice





# Procedure Cont.

- *Dripping nanopure water into liquid nitrogen*



# Procedure Cont.

- *Recovering the ice from liquid nitrogen*



# Procedure Cont.

*These are  
nanopure ice  
pellets*



# Procedure Cont.

- *Pouring ice into the coffee grinder*



# Procedure Cont.

- *This is nanopure snow.*



# Procedure Cont.

- Filling the apparatus



# Procedure Cont.

- *Close up of the apparatus filled with snow.*



# Procedure Cont.

- *Fastening the top of the apparatus*





# Procedure Cont.

- *Attaching the propane canister*



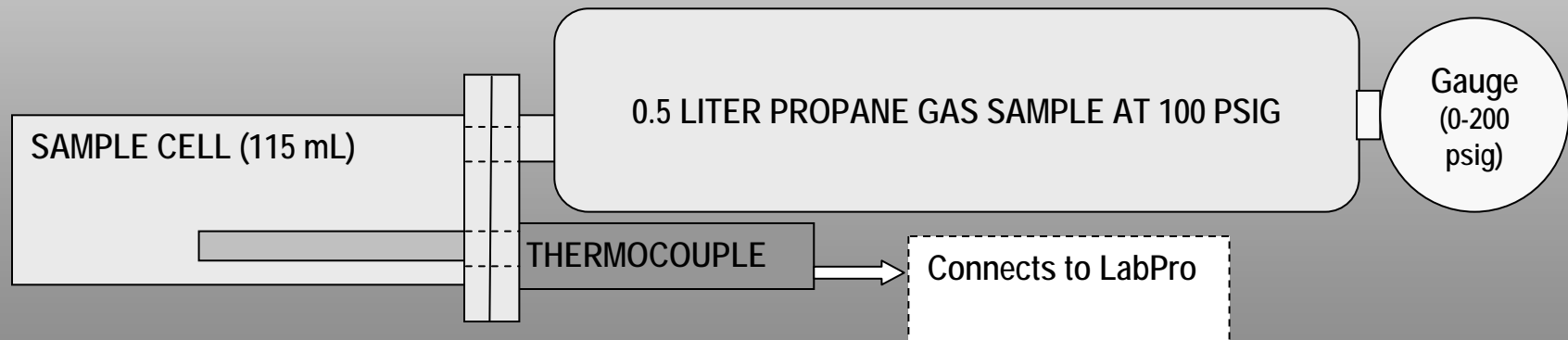
# Procedure Cont.

- *The whole apparatus is placed in ice for 24 hours.*



# *Schematic of Experimental Apparatus*

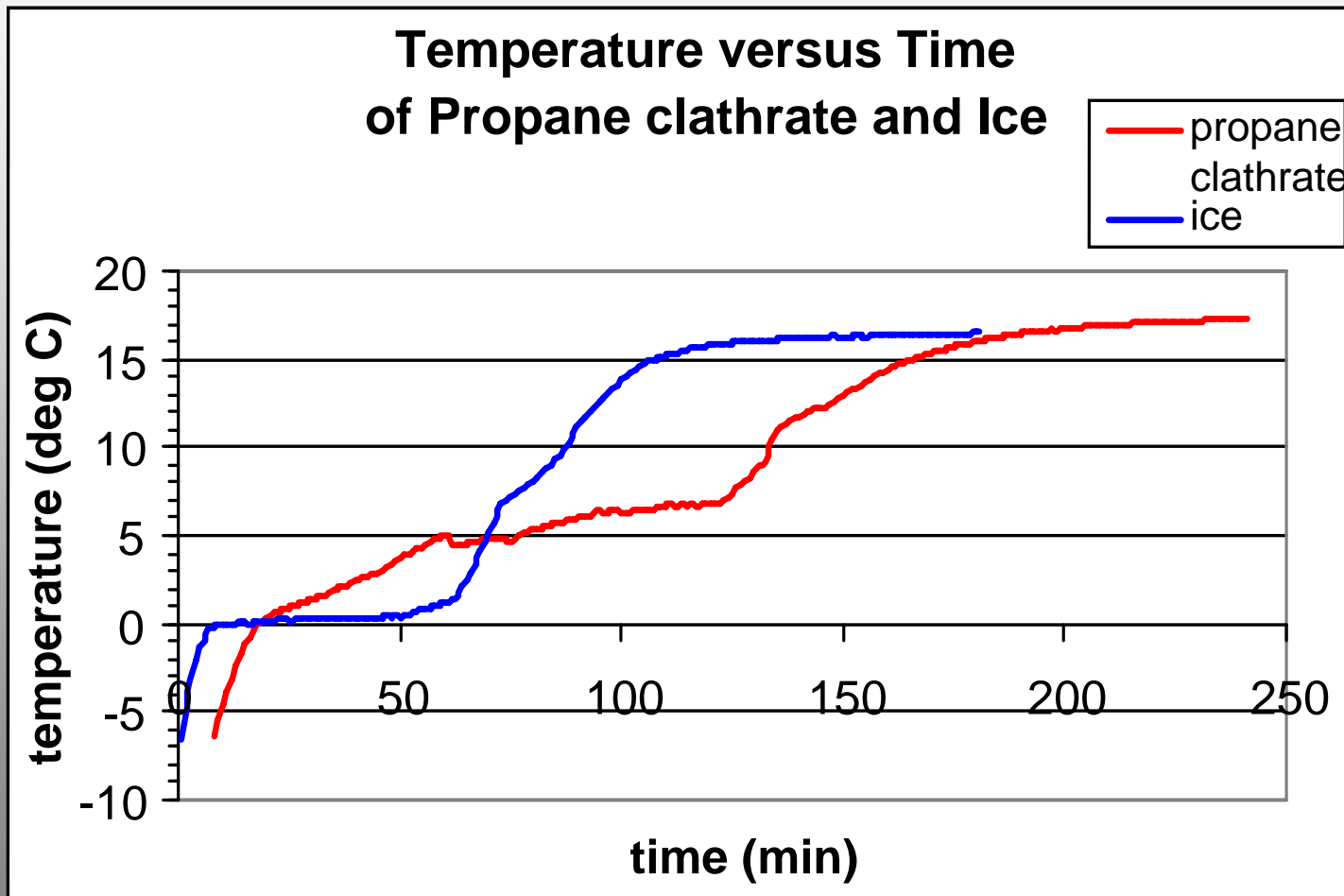
- Fill apparatus with ice and charge with propane. The apparatus is then left in an ice bath for 24 hours.



- Gather data with the Vernier LabPro thermocouple coupled to a computer.



# Sample data



# Burning propane hydrate clathrate



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