

# Science School: "An Engine Driven by Thermal Expansion of Air"

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Shibata lab.

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# 1. Introduction

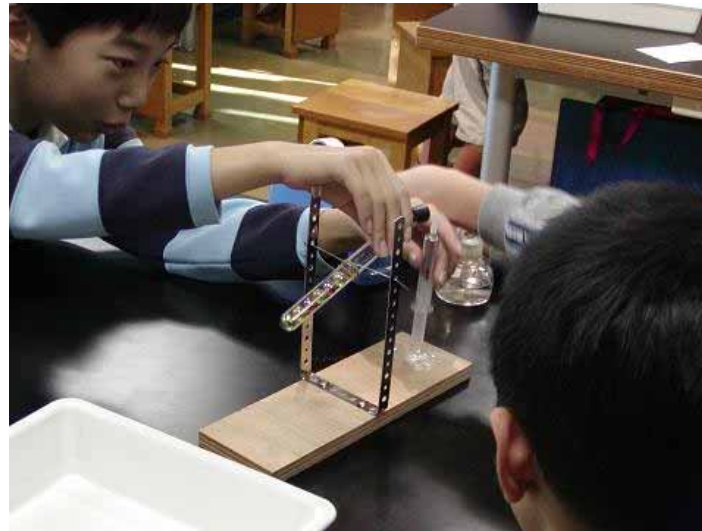
Shibata-lab. has had Science School in total 10 times at Tamarokuto Science Museum since 2001.

## Purpose of Science School

- To study physics ourselves making use of these occasions
- To teach physics to public
- To learn how to present



Outside of Tamarokuto  
Science Museum,  
Nishi-Tokyo-shi, Tokyo



Themes of Science School held in this fiscal year

2004, 5/23	Light and Rainbow
2004, 7/17,18	Telescope
2004, 11/23	Thermal Expansion and Contraction of Air, Stirling Engine
2005, 2/11	not yet decided

I organized Science School on November 23rd, 2004.  
36 pupils were selected out of 84 applicants (Age 8 ~ 14 ).  
About 40 parents also attended.

## 2. Purpose of this Science School (2004.11.23)

Subject: Thermal Expansion and Contraction of Air,  
Let's make a toy driven by heat.

### Purposes of this class

- Pupils understand thermal expansion of air.
- Pupils understand the relation between pressure and volume of air.

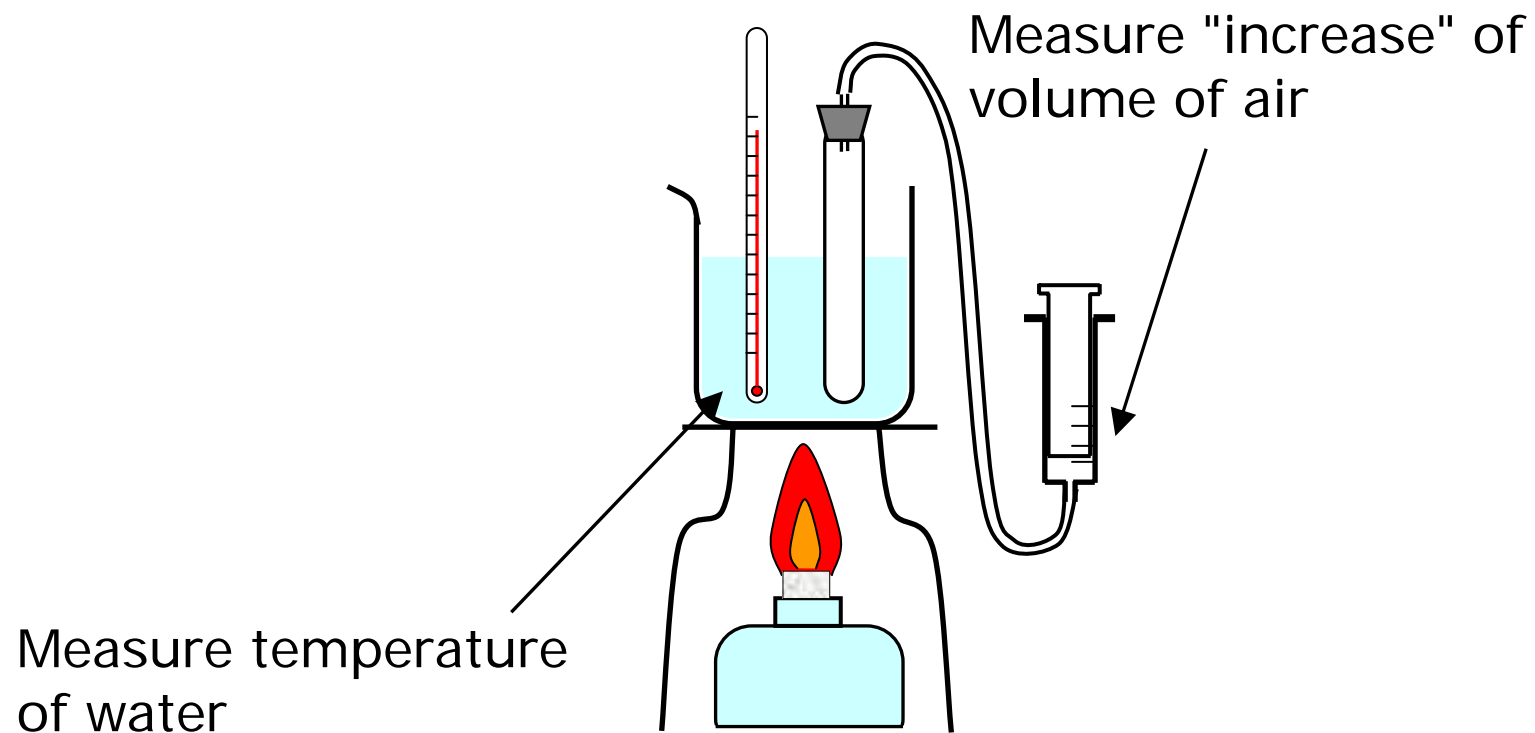
(Boyle-Charle's law)

- Pupils learn that heat can be transformed to work.

# 3. Experiments

We did two experiments to learn about Boyle-Charle's law.

Relation between temperature and volume of air

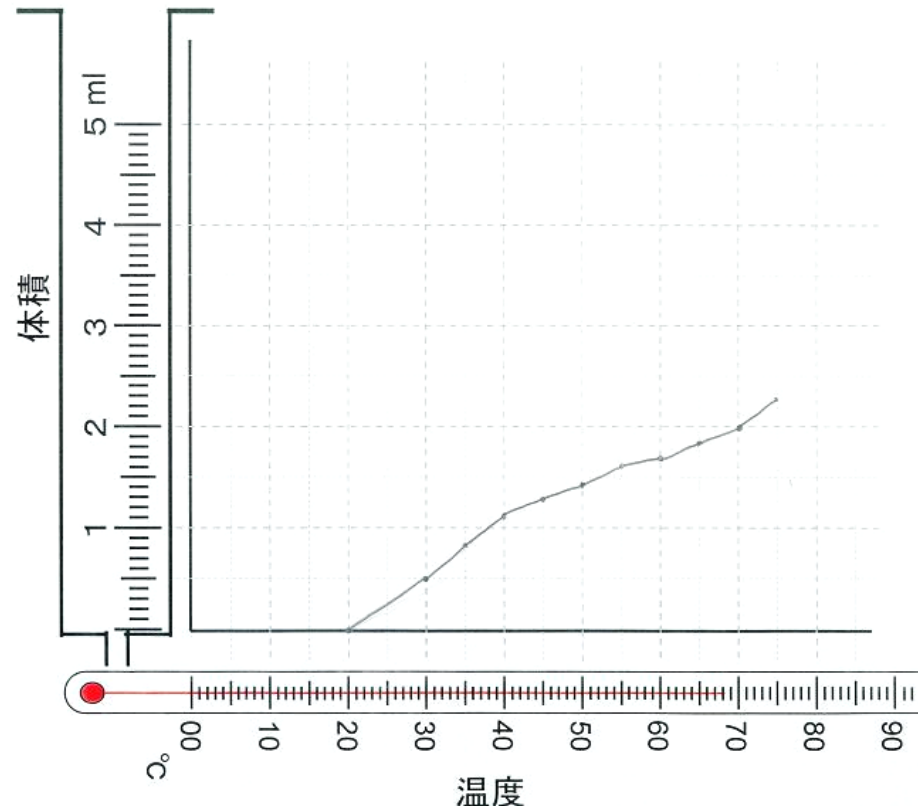


## Results

- Volume increases gradually with temperature.
- Points plotted are almost linear.

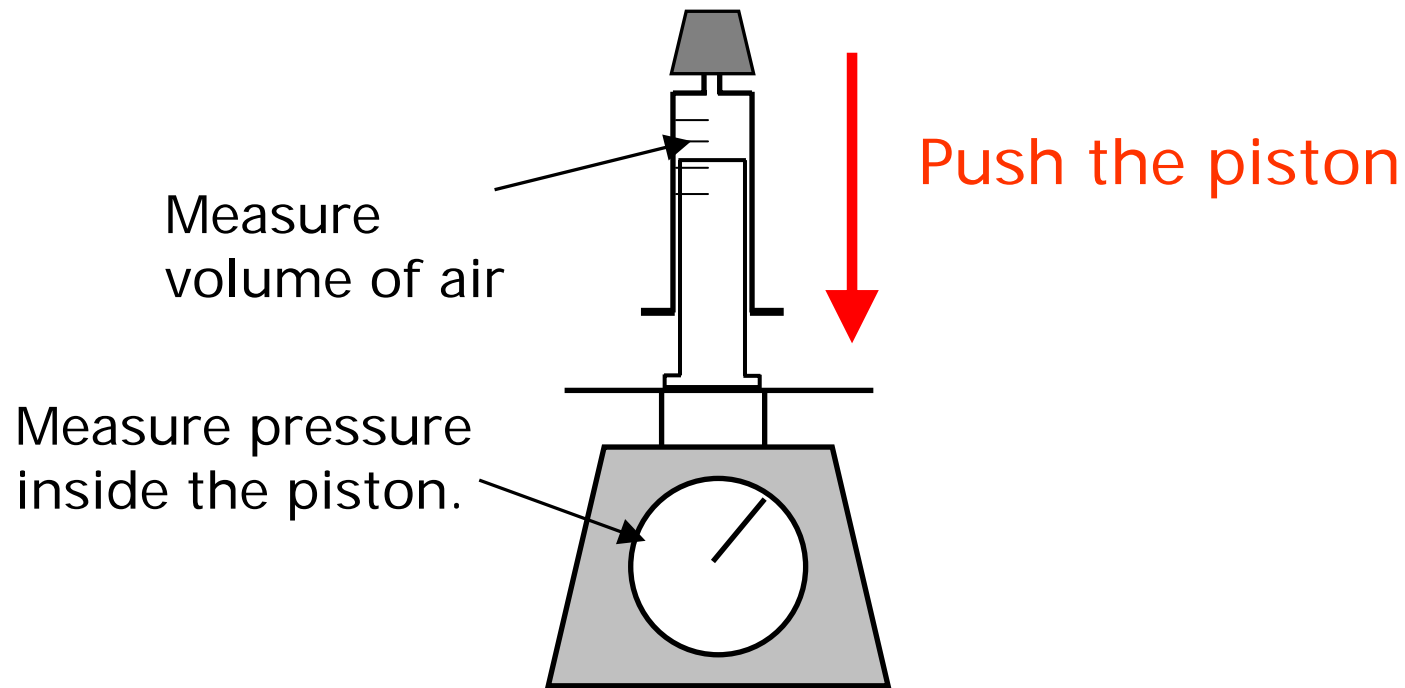
温度と体積の関係をしらべてみよう！

温度 [°C]	注射器の 体積[ml]
30	0.5
35	0.85
40	1.1
45	1.3
50	1.4
55	1.6
60	1.7
65	1.8
70	2
75	2.3
80	



A graph drawn by the pupils at Science School

## Relation between pressure and volume of air



With this experiment, pupils learned that volume is inversely proportional to pressure.

# Making a toy using Stirling Engine

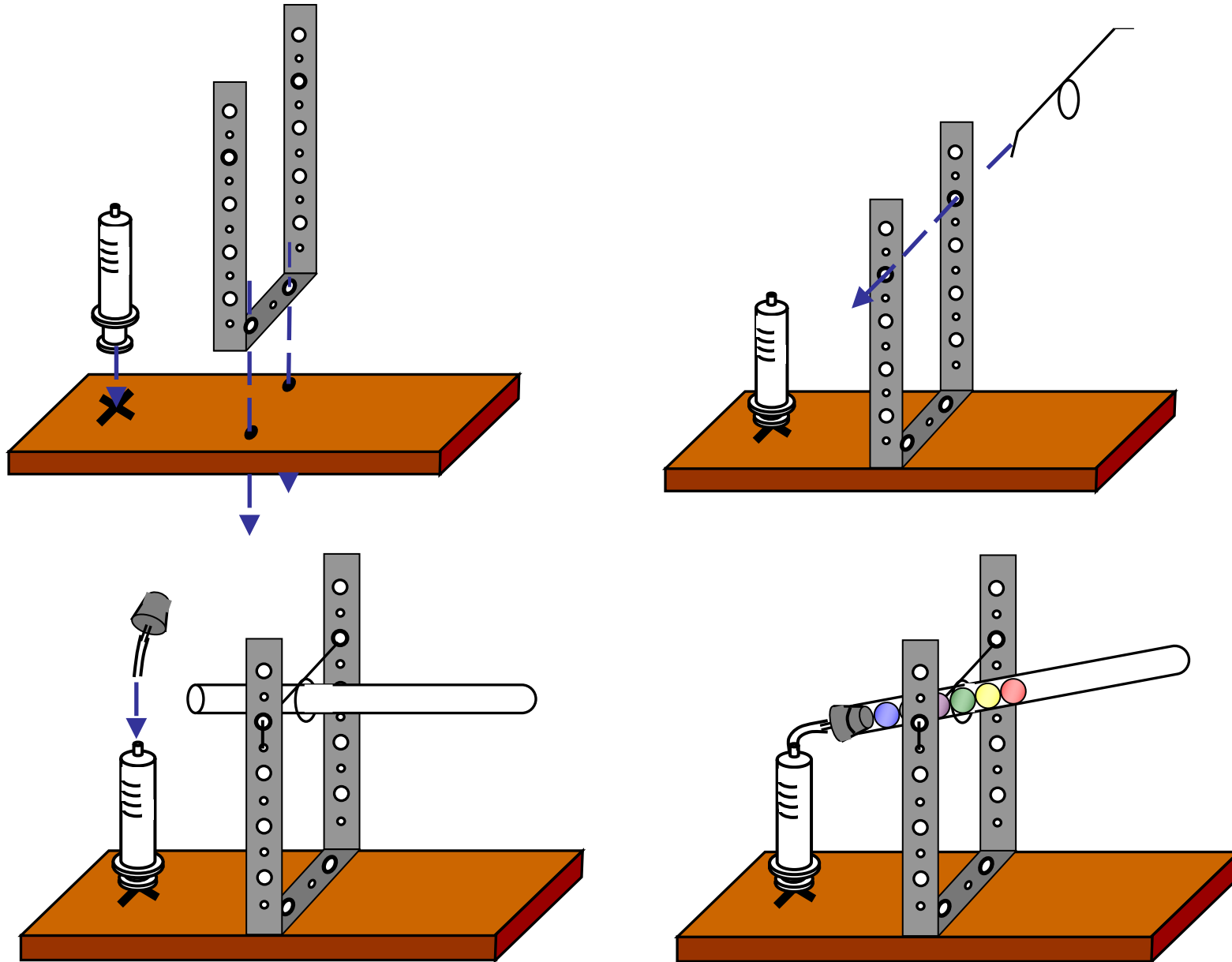
Stirling Engine was invented by Robert Stirling in 1816. It is driven by thermal expansion and contraction of air. Pupils made "B-dama (marble)" Stirling Engine.



Parts of "B-dama" Stirling Engine



# Making a toy using Stirling Engine

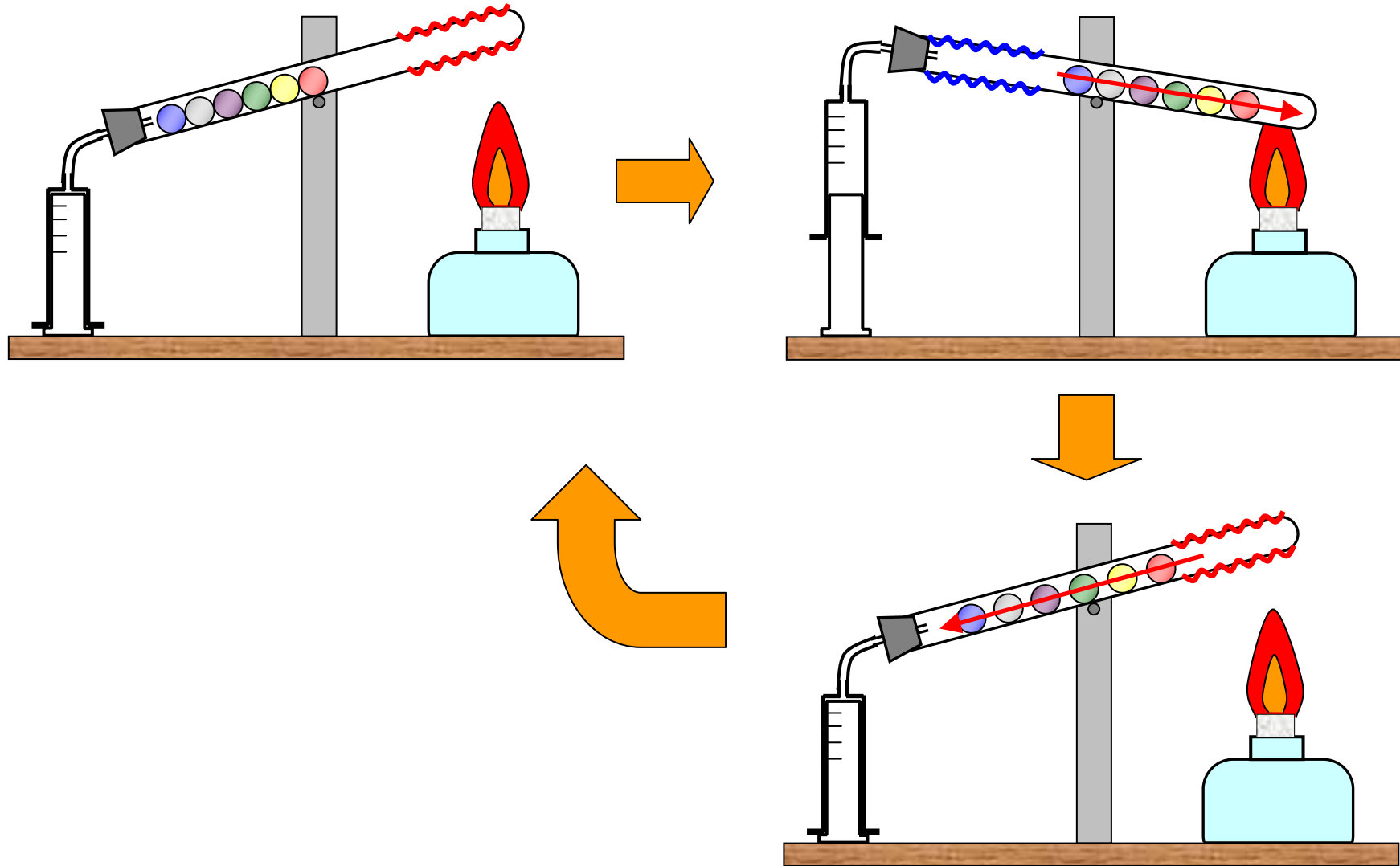


# Mechanism of "B-dama" Stirling Engine



"B-dama" Stirling Engine

# Mechanism of "B-dama" Stirling Engine



## 4. Summary

- I prepared and organized Science School at Tamarokuto Science Museum on November 23rd, 2004.
- Pupils did experiments on thermal expansion of air and relation between pressure and volume.  
(Boyle-Charle's law)
- Pupils made a toy of "B-dama" Stirling Engine, and learned that heat can be transformed to work.
- Making use of this occasion I myself learned about Stirling Engine and its applications.



# A hot-air balloon

We performed flight experiment of hot-air balloon.

Structure of the hot-air balloon

Material: polyethylene

Thickness: 15 microns

Weight: 143 g

Volume: 2.73 m<sup>3</sup>

Temperature of inside: 40  
(heated by a hair dryer)



Flying hot-air balloon