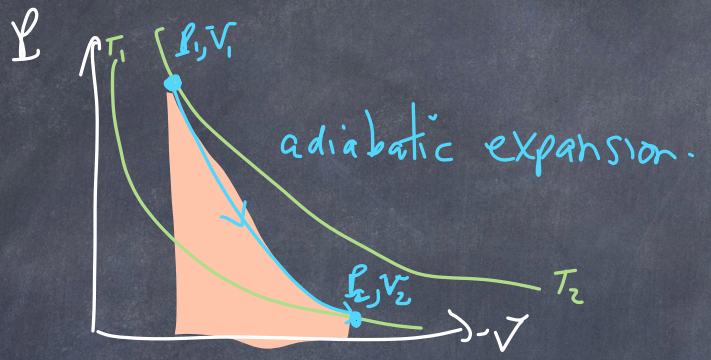
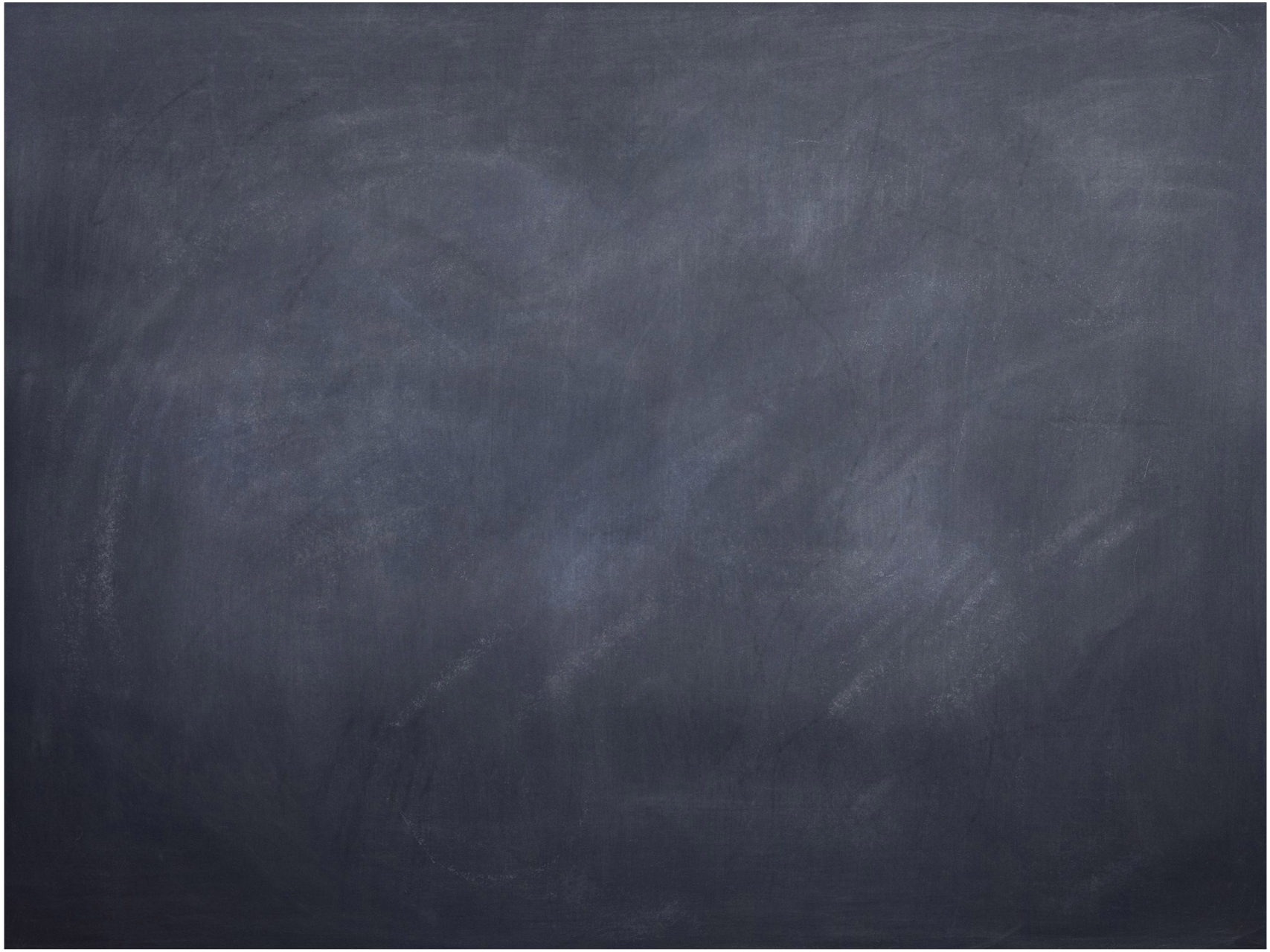
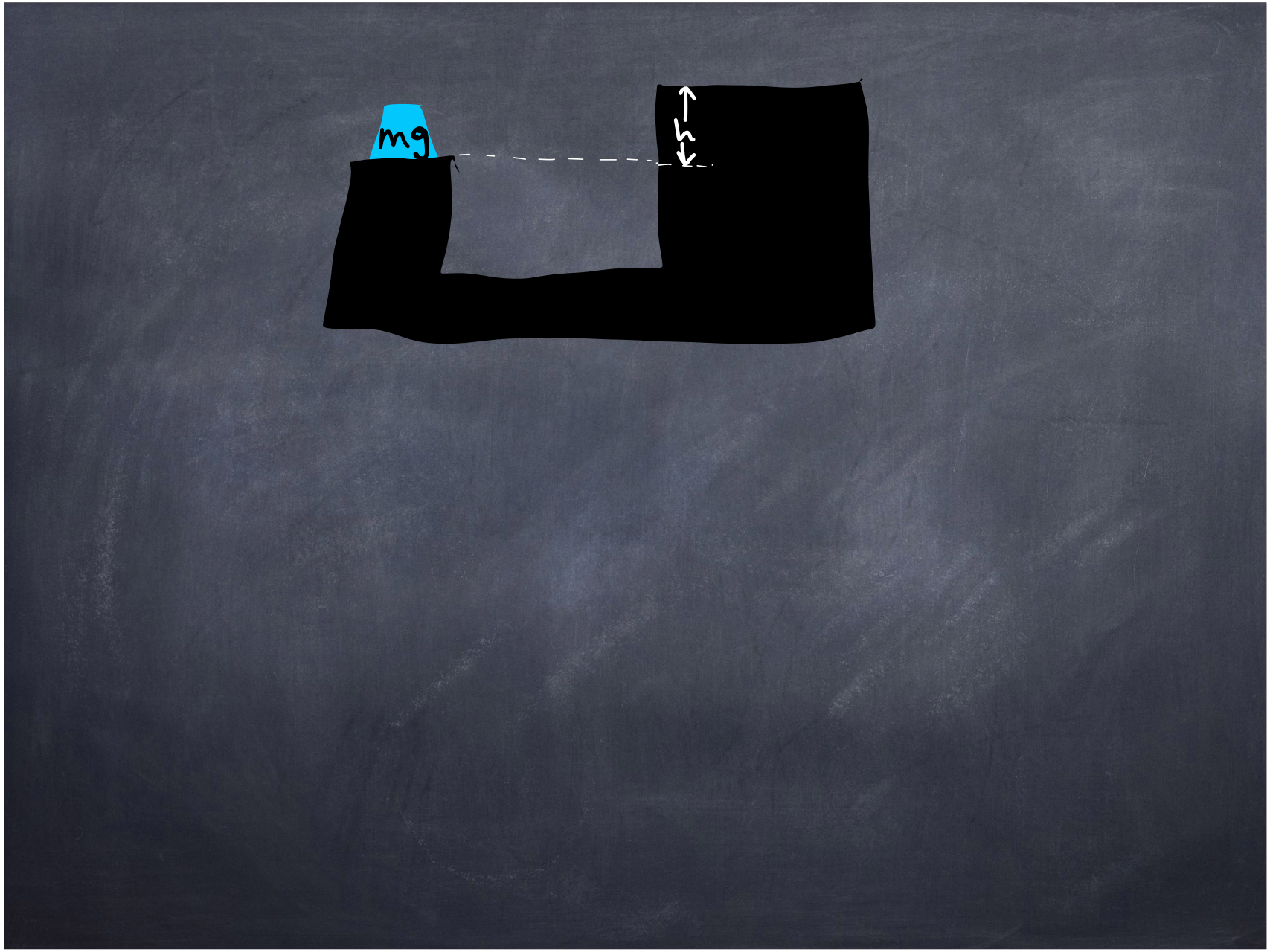
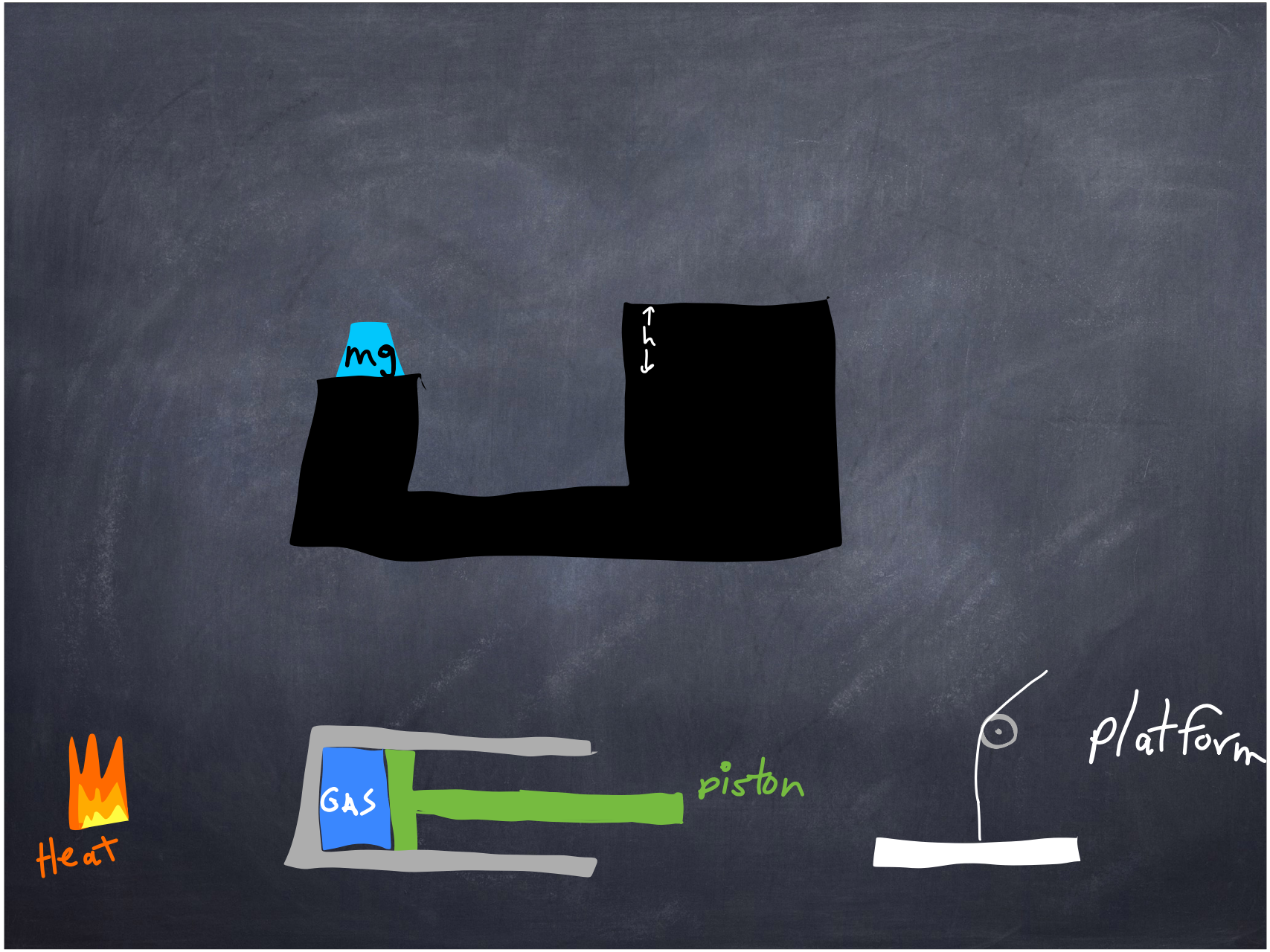
PHY117 HS2024

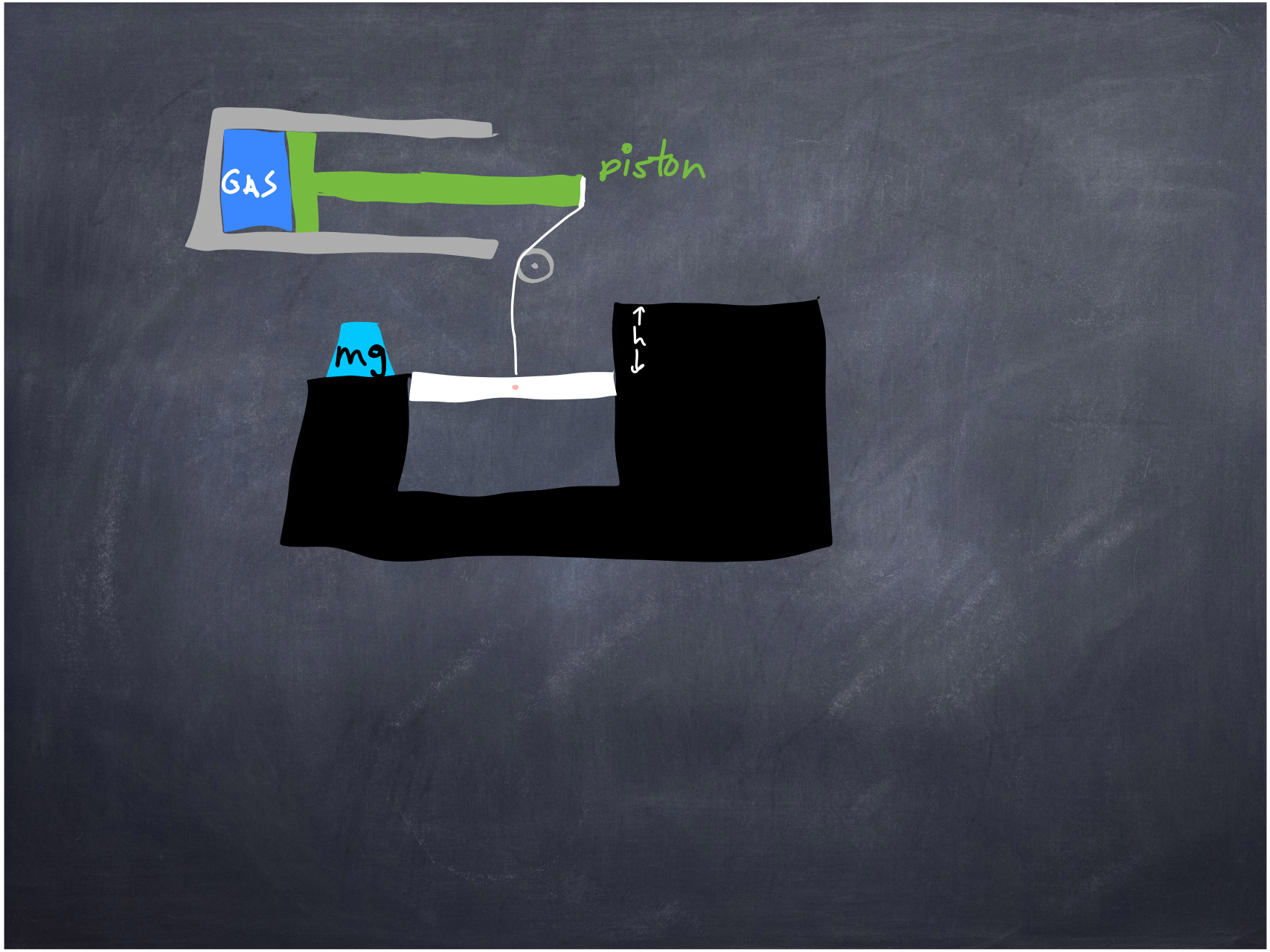
Week 7, Lecture 2
Oct. 30th, 2024
Prof. Ben Kilminster

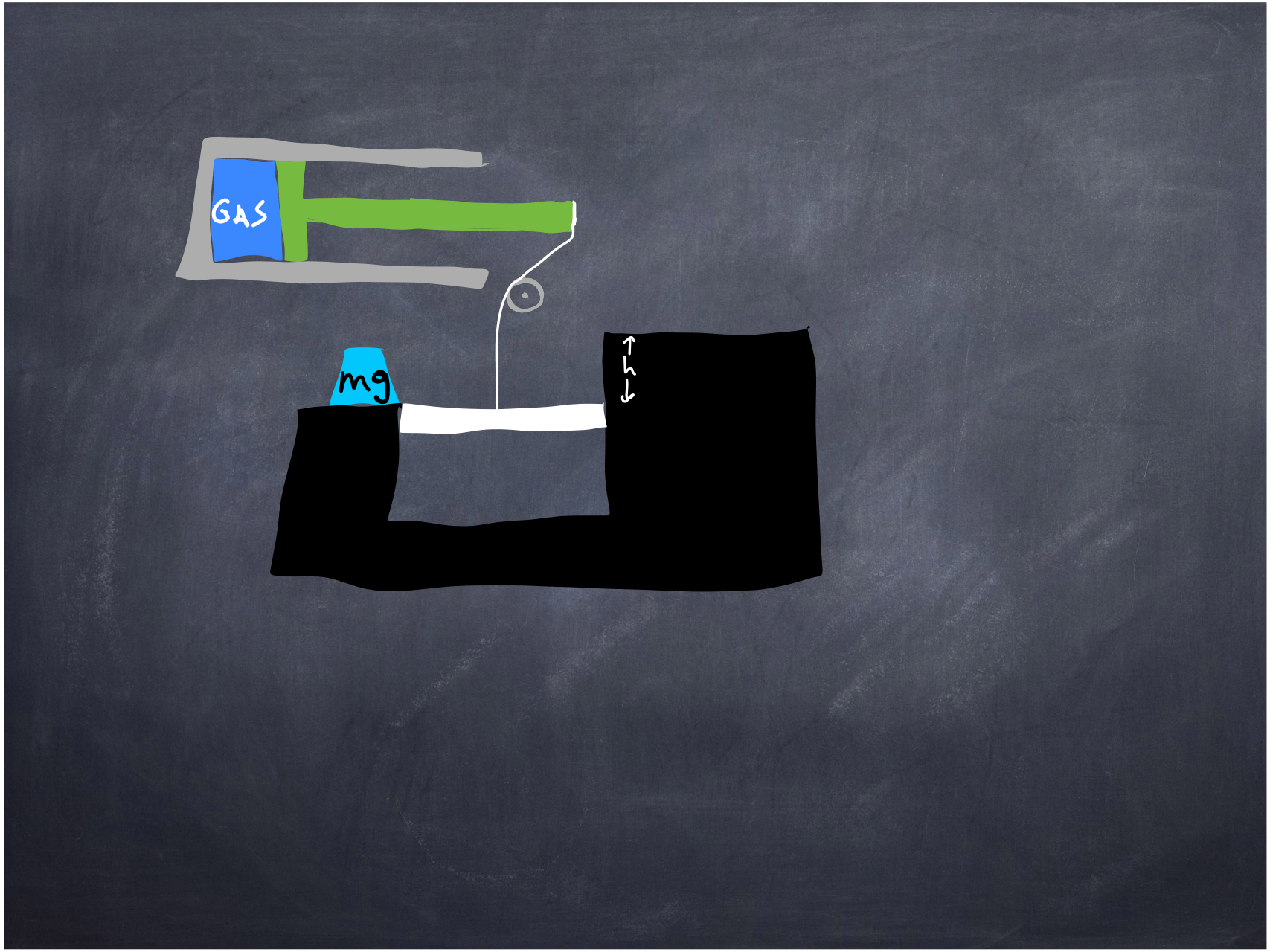

P
T_1
P_1, V_1
adiabatic expansion.
P_2, V_2
T_2
V

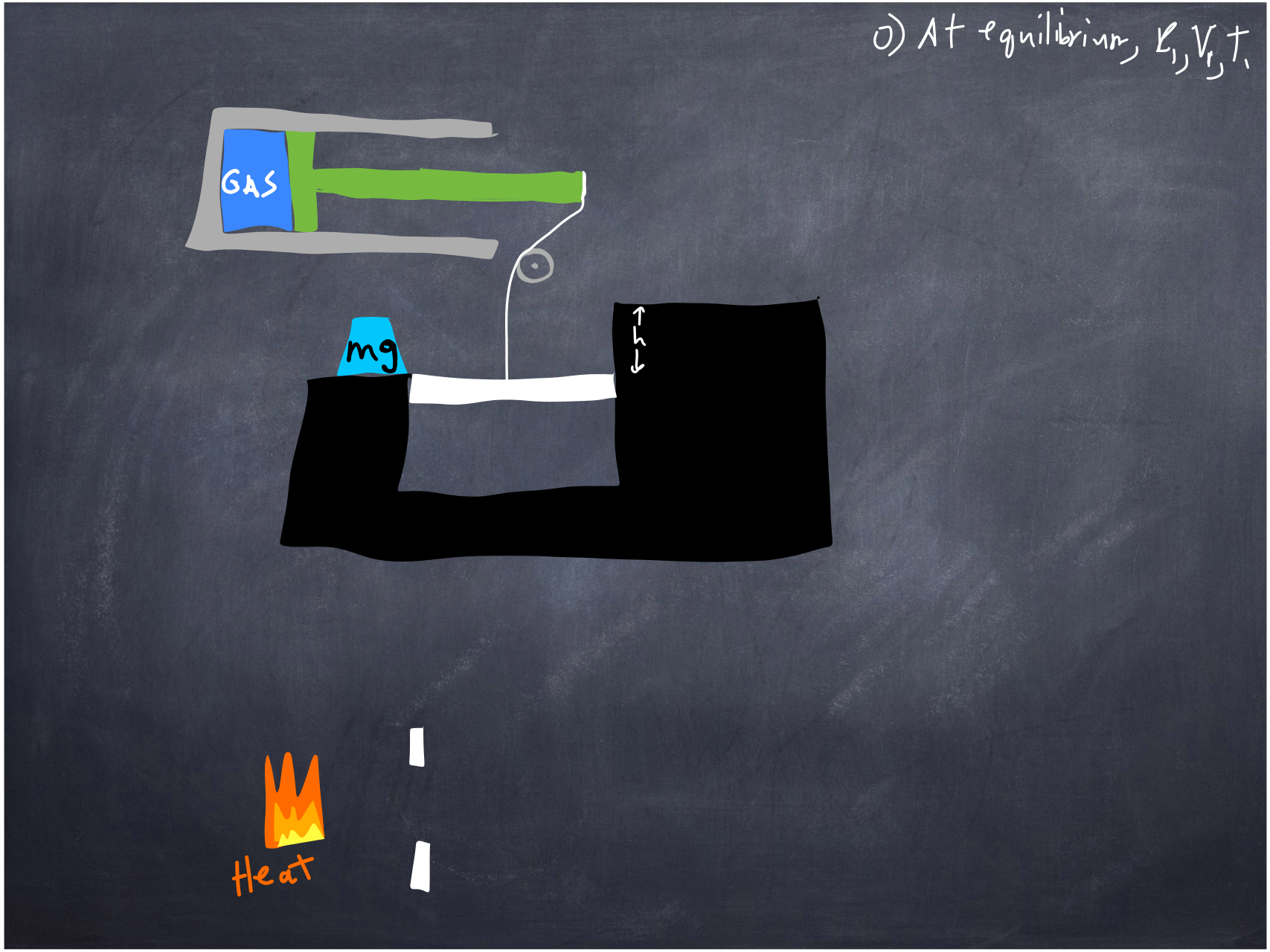



mg
h

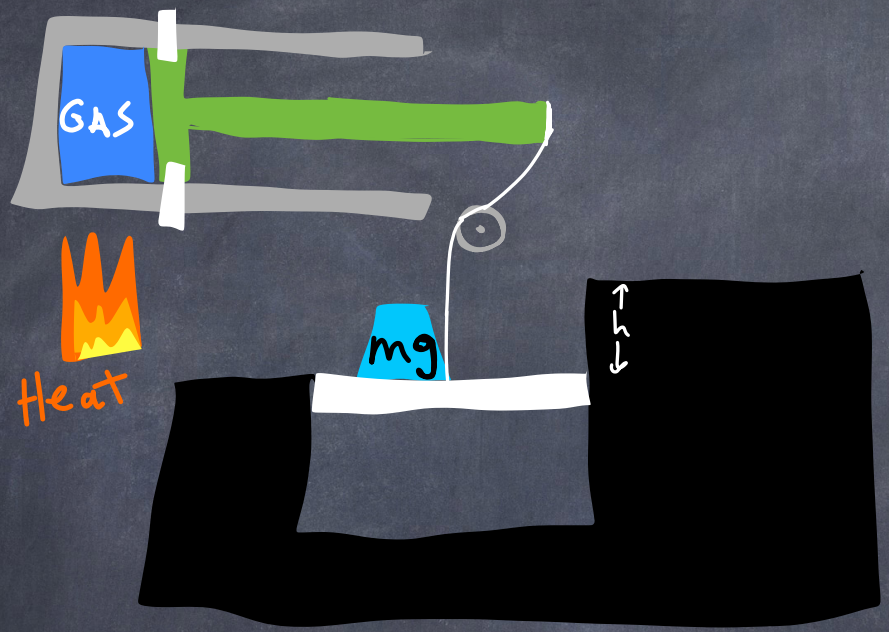

mg
h
Heat
GAS
piston
platform


GAS
piston
mg
h


GAS
mg
h


0) At equilibrium, P_1, V_1, T_1
GAS
mg
h
Heat

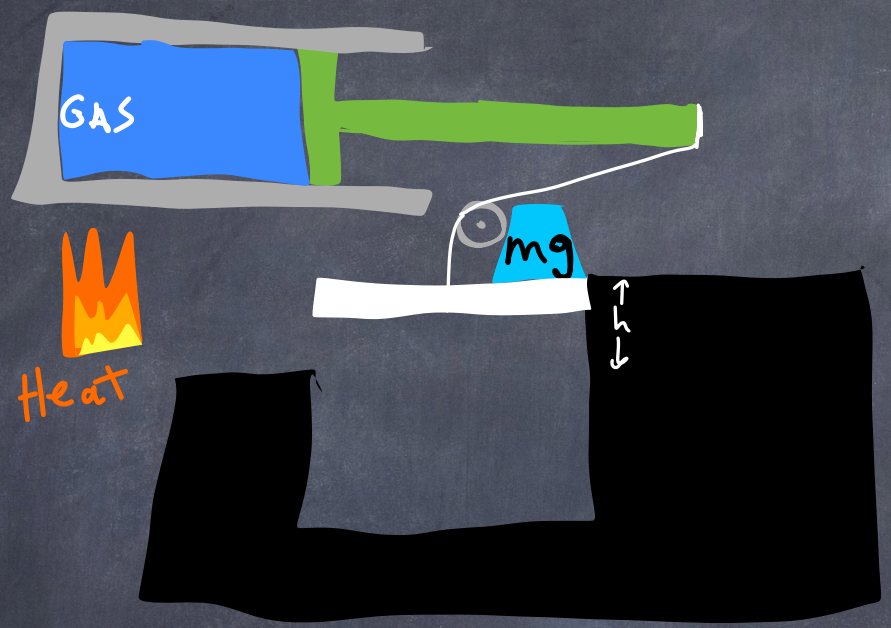
a) $P_1 \to P_2$, V_1 constant



0) At equilibrium, P_1 V_1 T_1

a) We fix volume at V_1. Then heat gas at constant volume. So pressure increases to P_2. We slide weight on platform. The pressure P_2 can now hold the weight mg.

a) $P_1 \to P_2$, V_1 constant
b) $V_1 \to V_2$, P_2 constant



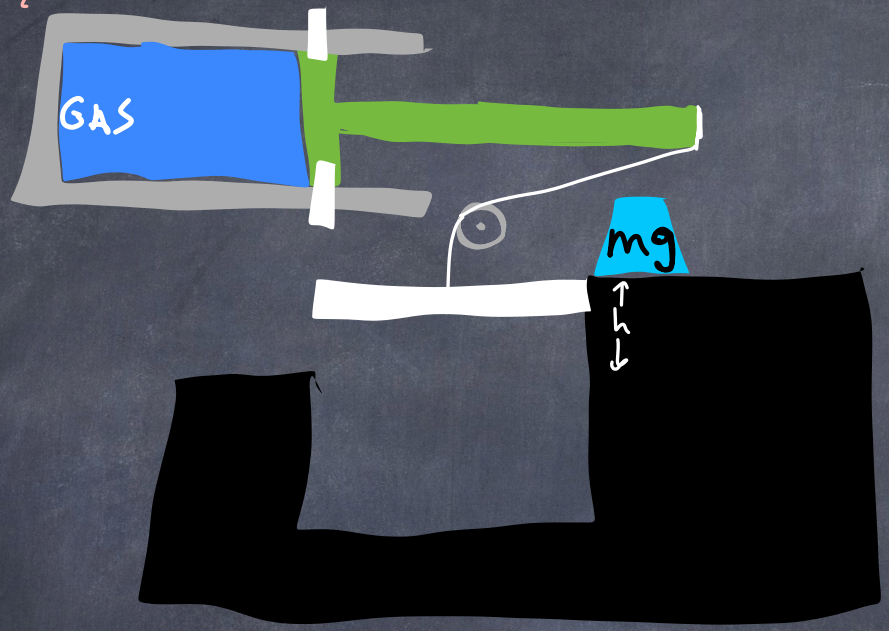
0) At equilibrium, P_1, V_1, T_1

a) We fix volume at V_1. Then heat gas at constant volume. So pressure increases to P_2. We slide weight on platform. The pressure P_2 can now hold the weight mg.

b) We continue to heat the gas until volume increases to V_2. This raises the weight a height h.

a) $P_1 \to P_2$, V_1 constant
b) $V_1 \to V_2$, P_2 constant

c) $P_2 \to P_1$, V_2 constant



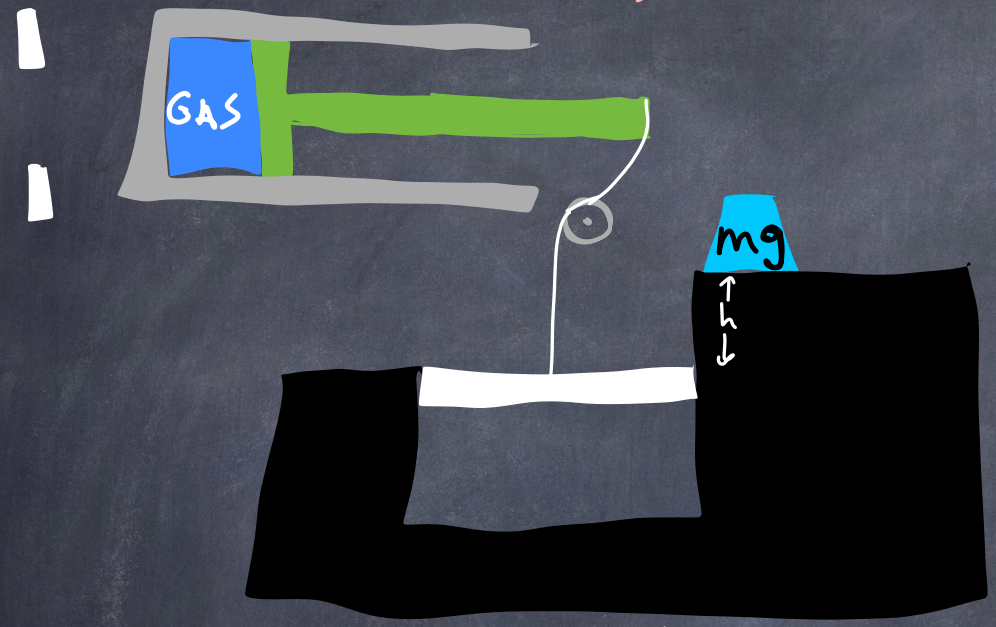
c) we fix the volume at V_2.
Slide over the weight.
Remove the heat.
Pressure will decrease at constant volume V_2 to P_1,

0) At equilibrium, P_1, V_1, T_1

a) We fix volume at V_1.
Then heat gas at constant volume.
So pressure increases to P_2.
We slide weight on platform. The pressure P_2 can now hold the weight mg.

b) We continue to heat the gas until volume increases to V_2.
This raises the weight a height h.

a) $P_1 \to P_2$, V_1 constant
b) $V_1 \to V_2$, P_2 constant
c) $P_2 \to P_1$, V_2 constant
d) $V_2 \to V_1$, P_1 constant



0) At equilibrium, P_1, V_1, T_1

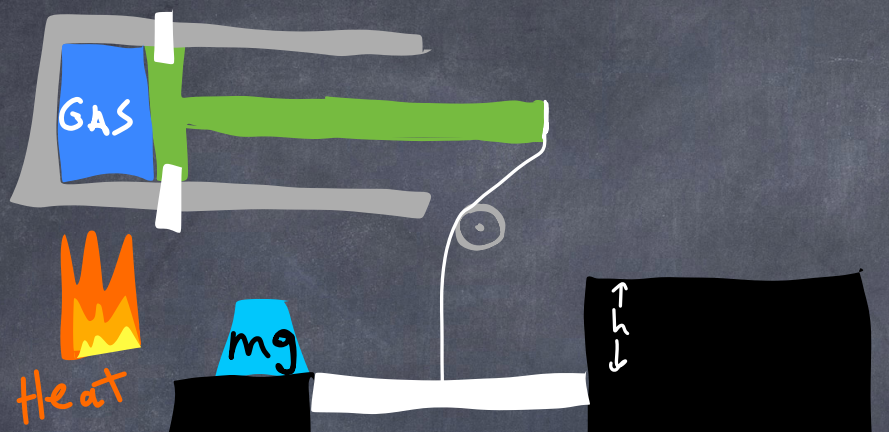
a) We fix volume at V_1. Then heat gas at constant volume. So pressure increases to P_2. We slide weight on platform. The pressure P_2 can now hold the weight mg.

b) We continue to heat the gas until volume increases to V_2. This raises the weight a height h.

c) We fix the volume at V_2. Slide over the weight. Remove the heat. Pressure will decrease at constant volume V_2 to P_1.

d) Unfix the volume. We continue to allow heat to be removed. The volume will decrease at constant pressure P_1 to V_1.

Summary:



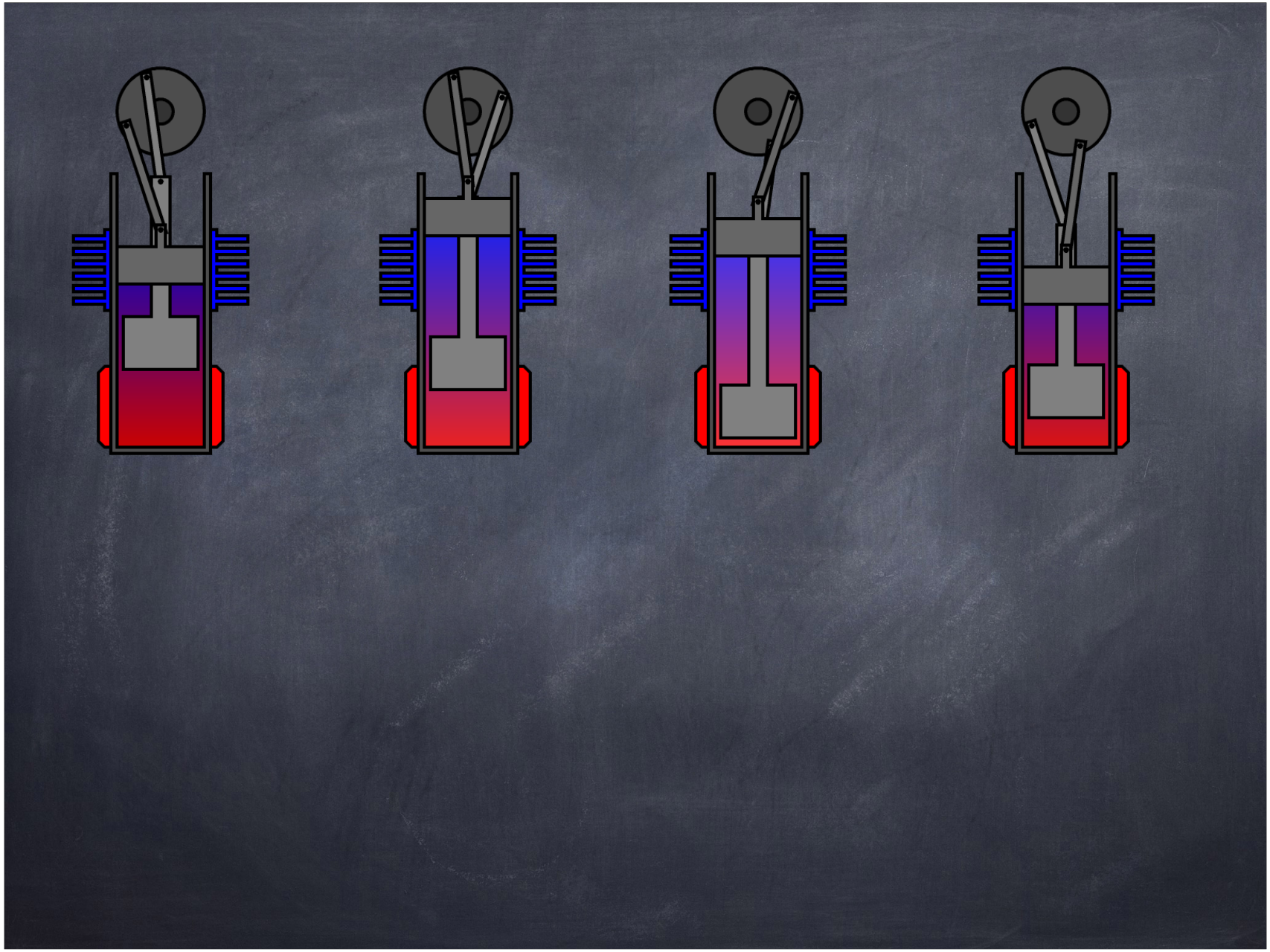
Cycle:

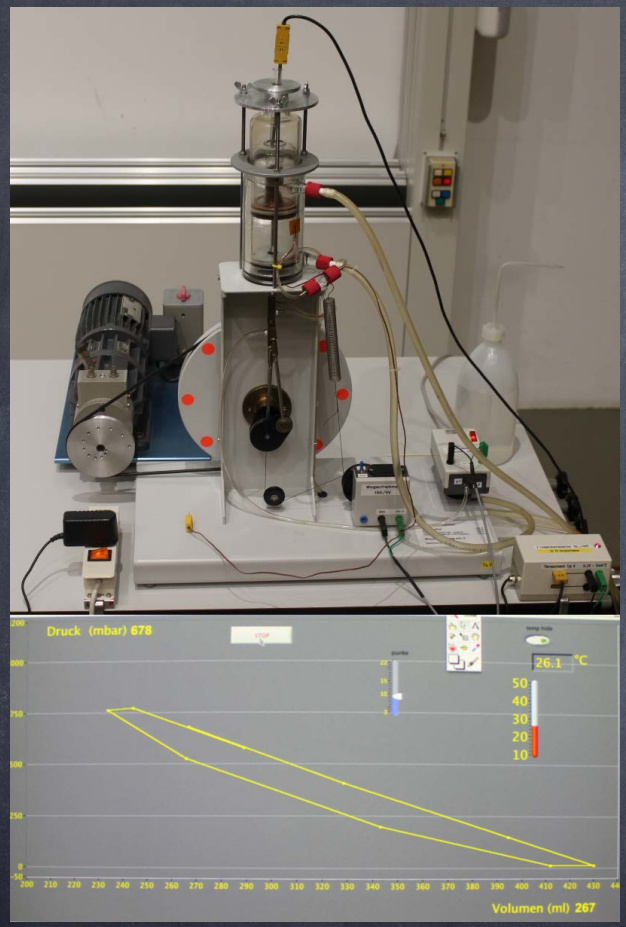
a: heat at fixed V, P increases
b: heat at fixed P, V increases
c: cool at fixed V, P decreases
d: cool at fixed P, V decreases

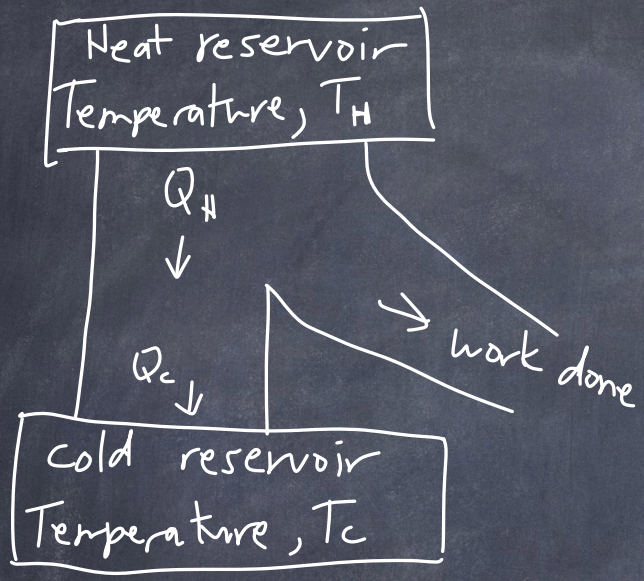
Draw: P vs. V cycle, showing heat coming in and out, show the work.

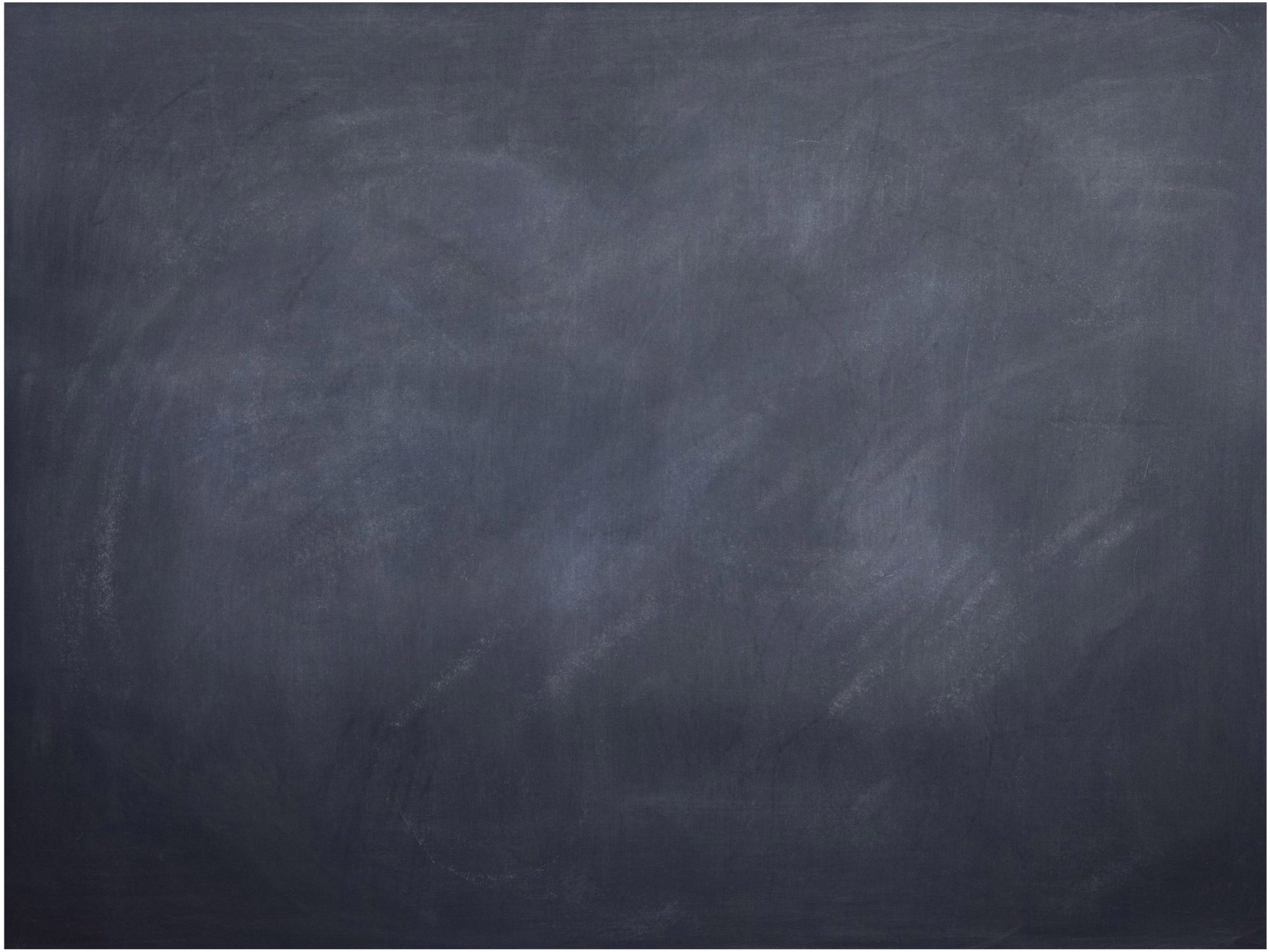
Calculate: ΔU, W, Q_{in}, Q_{out}. How do $P_1, P_2, V_1, V_2, Q_{in}, Q_{out}$ relate to h.

↑ height




Druck (mbar) 678
26.1 °C
50
40
30
20
10
Volumen (ml) 267


Heat reservoir
Temperature, T_H
Q_H
Q_C
work done
cold reservoir
Temperature, T_C

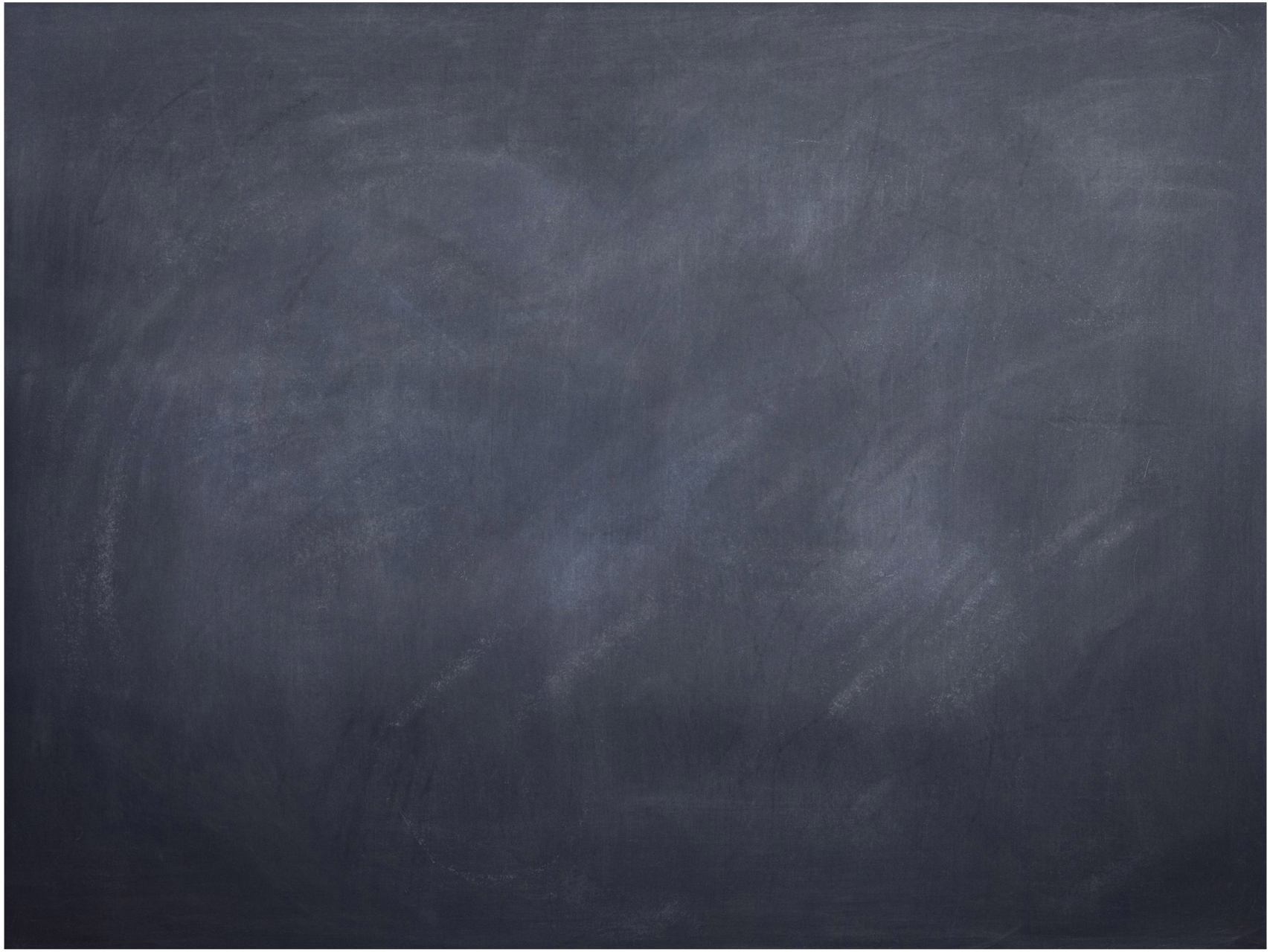


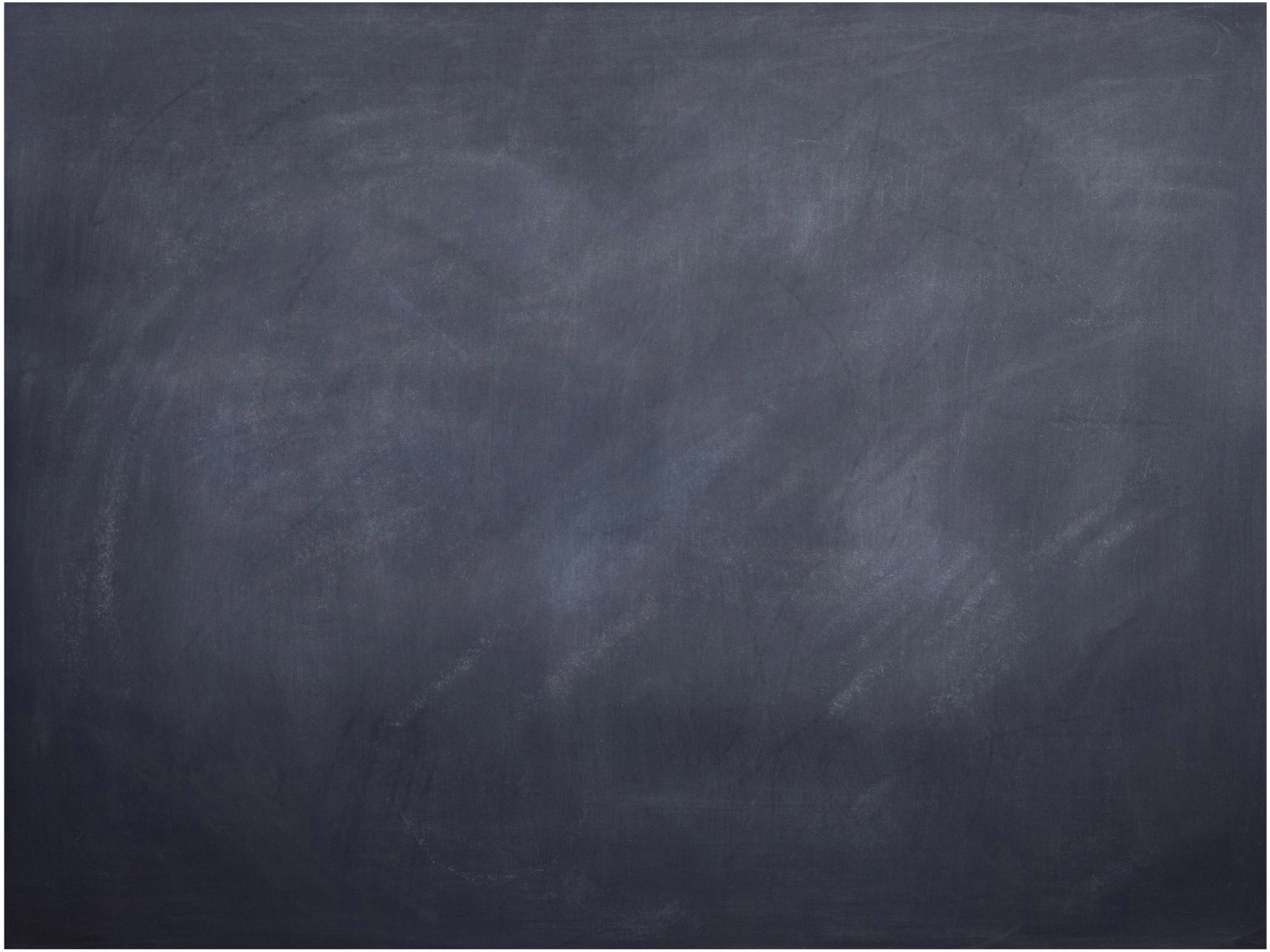
1: P_1, V_1, T_H

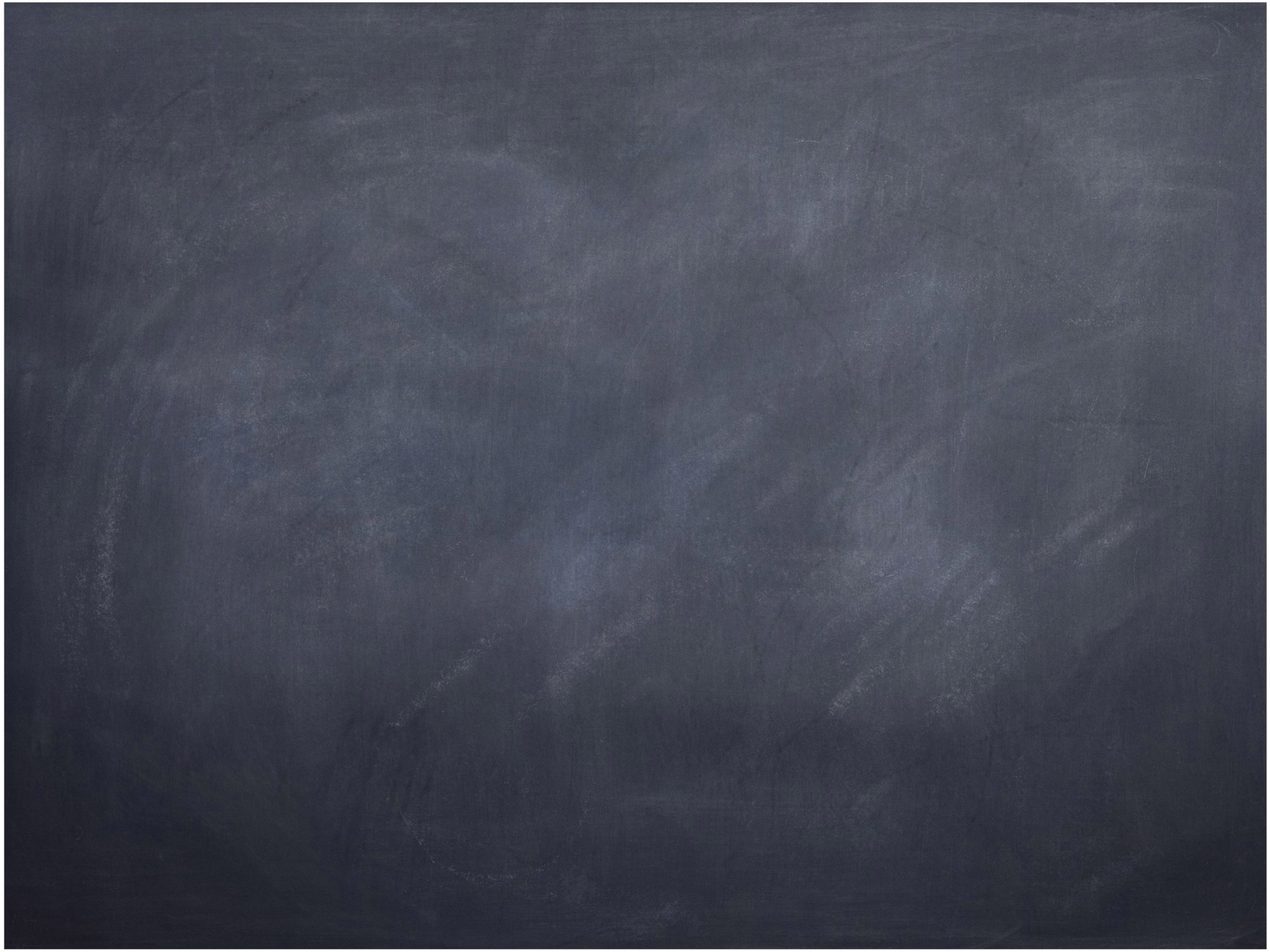
2: P_2, V_2, T_H

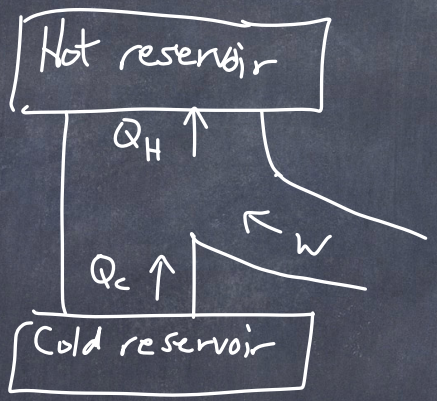
3: P_3, V_3, T_C

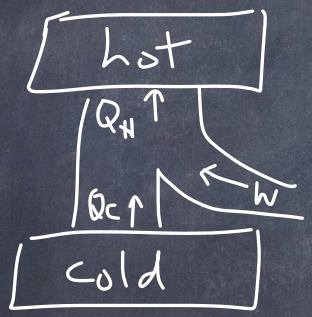
4: P_4, V_4, T_C

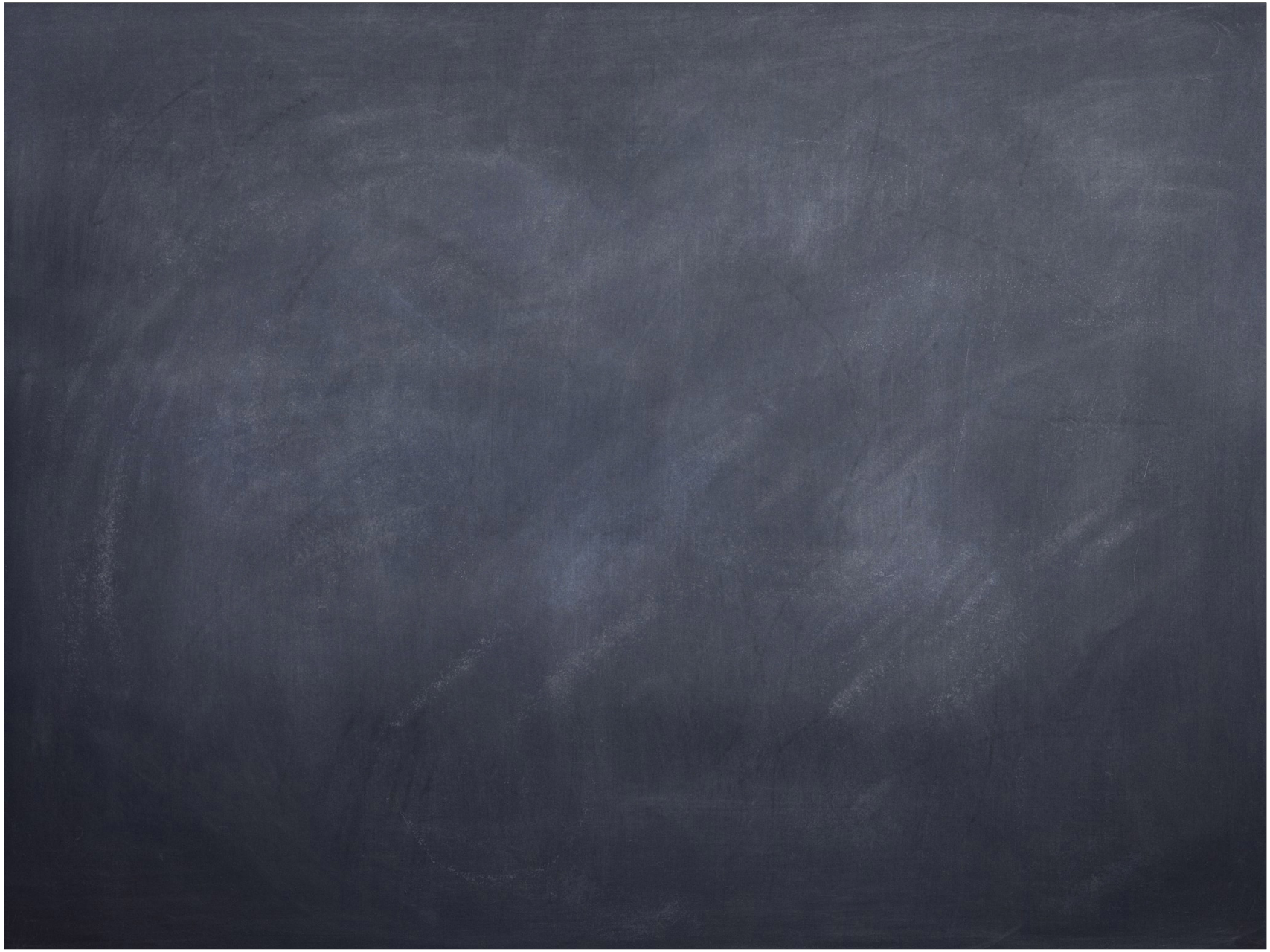


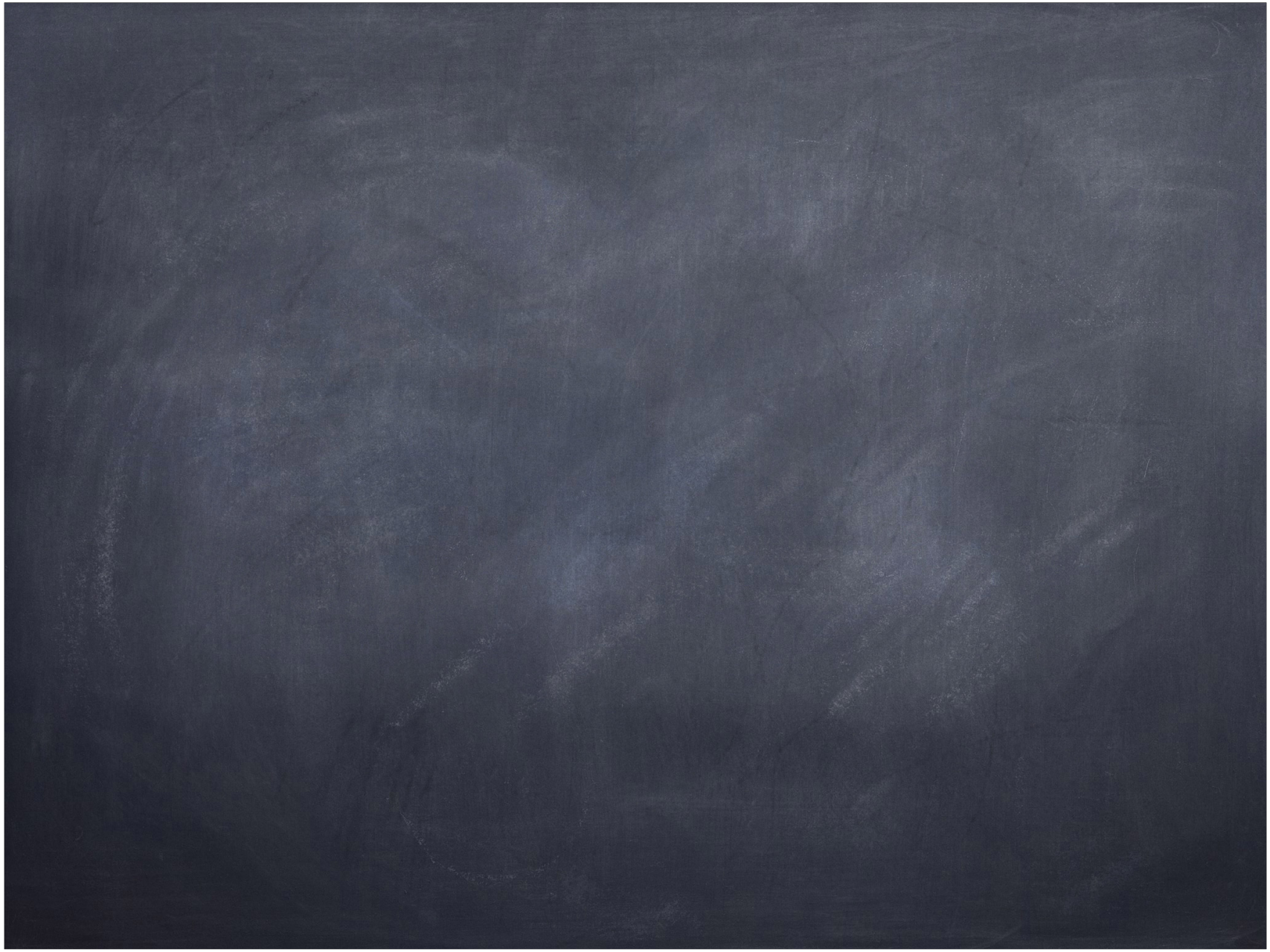


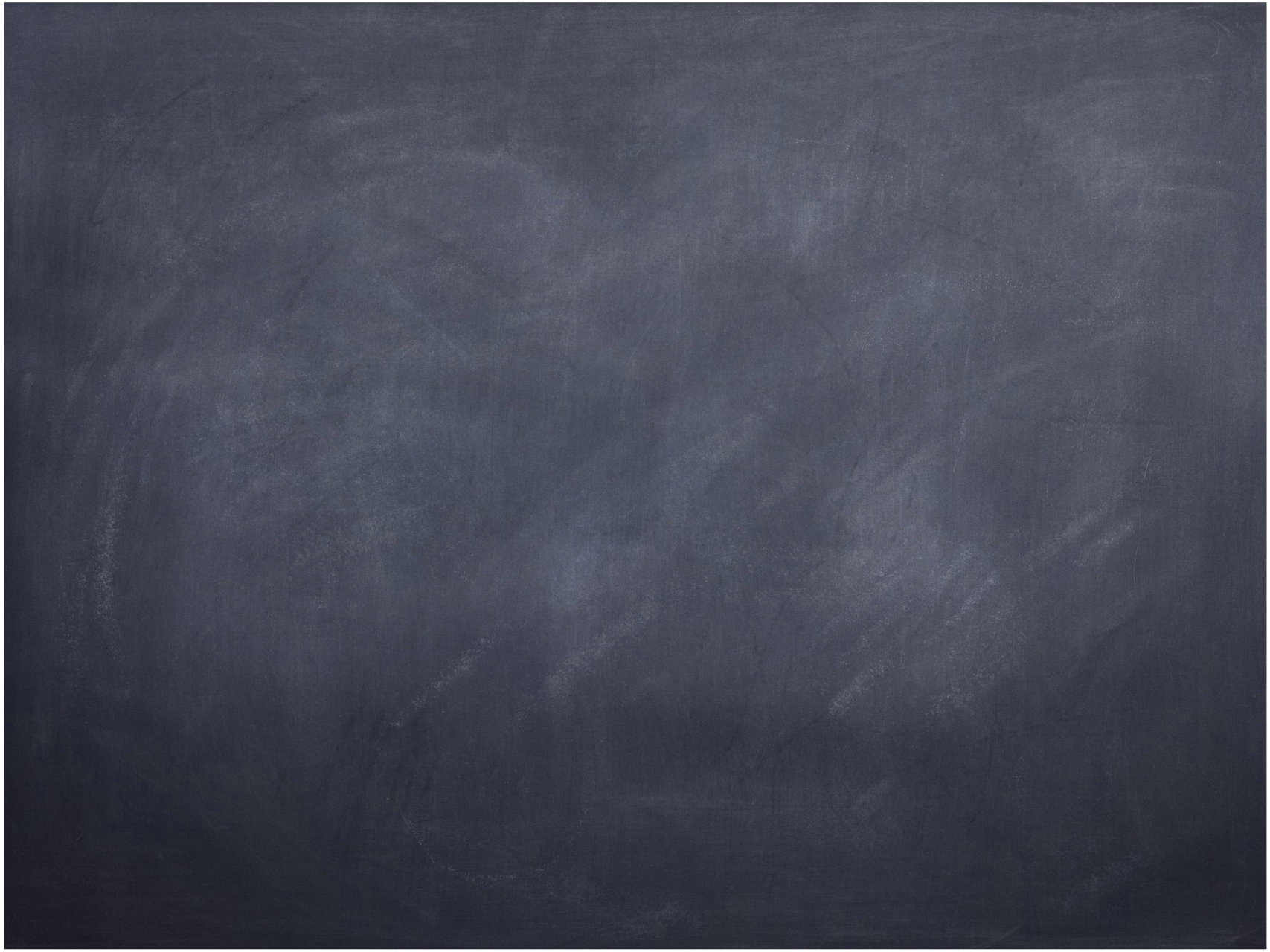


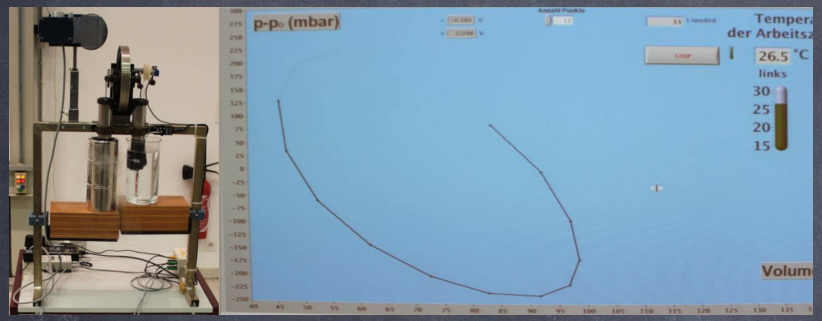

Hot reservoir
Q_H
W
Q_c
Cold reservoir

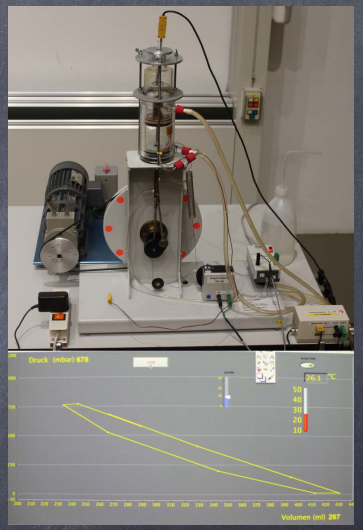

hot
Q_H
W
Q_C
cold








p-p₀ (mbar)
Temperatur der Arbeitsz
STOP
26.5 °C
links
30
25
20
15
Volum


Druck (mbar) 678
26.1 °C
Volumen (ml) 267

work can be done by heat

shape-memory alloy remembers its original molecular configuration at high temperatures