Physics 111

Lecture 26
Thursday, December 9, 2004

• Ch 18: PV diagrams
  isobaric process
  isochoric process
  isothermal process
  adiabatic process
  2nd Law of Thermodynamics

• Class Reviews/Evaluations

The Physics 111
Help Session

For the rest of the semester

• Thursday, Dec. 9, 3 - 5pm and 7 - 9pm

No Lab
This Week

I’ll be available for questions, though.

Announcements

Monday, Dec. 13, 2004
10:30 am – 12:30 pm
everything

• Part 1: Fluids & Thermodynamics
  3 sections - you choose 2
  7.5% of overall final grade
  topics covered:
    heat transfer: radiation, conduction, convection
    calorimetry
    fluids - buoyancy

Final Exam

Monday, Dec. 13, 2004
10:30 am – 12:30 pm
everything

• Part 2: Cumulative
  5 sections - you choose 3
  1 multiple choice section (required)
  4 other sections, one of them essay - you choose 2
  15% of overall final grade
  topics covered:
    MC (everything), graphing, kinematics,
    Newton’s Laws, work, energy, collisions,
    rotation, oscillations, thermodynamics

Announcements

I will put any constants and mathematical formulas that you might need on a single page attached to the back of the exam.

I will be available for questions, though.

Final Exam

Monday, Dec. 13, 2004
10:30 am – 12:30 pm
everything

• Part 1: Fluids & Thermodynamics
  3 sections - you choose 2
  7.5% of overall final grade

Exam

I will put any constants and mathematical formulas that you might need on a single page attached to the back of the exam.

I will be available for questions, though.
Work Done by Ideal Gas Systems

First, a few simplifying assumptions:

1. Quasi-static: the process occurs slowly enough that the system and its surroundings are always in thermal equilibrium.
2. Reversibility: the system and its surroundings must return to exactly the same states in which they were before the process.

Processes involving friction are irreversible.

Work Done by Ideal Gas Systems

Isobaric: Constant pressure processes

The work done equals the area under the curve.

In order for a gas to maintain a constant pressure while exchanging heat with its environment, the volume must change.

\[ W = P \Delta V \]
Specific Heat at Constant Pressure

How much heat is added/removed from an ideal gas when the volume changes at constant pressure?

Another tabulated property of the gas, the molar specific heat at constant pressure \( (C_p) \) helps us to figure it out:

\[
Q = nC_p \Delta T
\]

Work Done by Ideal Gas Systems

Isochoric: Constant volume processes

Here, the pressure in the gas changes in response to the heat fluxes, but the gas does no work since the volume is constant.

\[
W = 0
\]

Specific Heat at Constant Volume

How much heat is added/removed from an ideal gas when the pressure changes at constant volume?

Another tabulated property of the gas, the molar specific heat at constant volume \( (C_v) \) helps us to figure it out:

\[
Q = \Delta E_{th} = nC_v \Delta T
\]

Internal Energy & \( C_v \)

\[
\Delta E_{th} = nC_v \Delta T
\]

This important result is true, regardless of the process. A change in the internal or thermal energy of a gas is directly proportional to the change in temperature. The proportionality constant is the number of moles times the molar heat capacity at constant volume.
Specific Heat: $C_V$

For a monatomic ideal gas, we can solve exactly.

In an isochoric (constant volume) process, the work done by the system equals 0. So

From kinetic theory we have

So, we get

Specific Heat: $C_P$

For a monatomic ideal gas, we can solve exactly.

From the 1st Law of Thermodynamics:

For isobaric processes:

And for a monatomic, ideal gas, we know

From the ideal gas law:

Work Done by Ideal Gas Systems

Isothermal: Constant temperature processes

From the ideal gas law:

So there’s a direct relationship between $P$ and $V$.

Work Done by Ideal Gas Systems

Isothermal: Constant temperature processes

Note that the isotherms form a family of curves asymptotic to the $P$ and $V$ axes, with higher temperatures found as you move diagonally up and to the right.
A cylinder contains 7.0 g of diatomic nitrogen gas. How much work does this gas do on its surroundings when it is compressed to half its original volume at a constant temperature of 80°C?

Worksheet #3

Work Done by Ideal Gas Systems

Adiabatic: No heat flows into or out of the system

The work done equals the area under the curve.

From the 1st law with \( Q = 0 \):

\[
W = -nC_v \Delta T
\]

Entropy: A measure of the lack of order in a system

High order (low entropy):

\[
\begin{array}{c}
\text{\begin{tikzpicture}
\end{tikzpicture}}
\end{array}
\]

Low order (high entropy):

\[
\begin{array}{c}
\text{\begin{tikzpicture}
\end{tikzpicture}}
\end{array}
\]

These systems aren't static either: if \( T > 0 \), the molecules are moving around as well.

What happens when I bring these two systems into thermal contact with one another?
Ch 18: The Laws of Thermodynamics

2nd Law of Thermodynamics

Entropy of an isolated system never decreases. Entropy will always remain the same (best case scenario for systems in thermal equilibrium with their surroundings) or increase until they reach thermal equilibrium.

In order to increase the order of a system, you need to do work on the system. (Think of cleaning your room.)

The universe tends toward less order with time. So, it’s quite natural that your room gets dirty.

Statement from your text: Heat is always transferred from the hot system to the cold system when they come into thermal contact.

Congratulations!

You made it!

Good luck with your studying and in all of your finals. Remember to get a good night’s sleep.

Have a very Merry Christmas and a Happy New Year!

Please fill out all of the evaluation materials.

You will receive 5 CP points each.

Department form
Physics 111 class form

I appreciate your time and comments and will read them over before the start of Physics 112 in the spring.