Physics 2c Lecture 29

Exam Preparation I

Exam Preparation

- Thursday & Friday lectures this week provide examples of the kind of things I might ask about in the final.
- This is by no means complete !!!
- To prepare, I would:
  - First, do all the quiz questions again. Make sure you know how to solve all of them, and you will pass the final exam.
  - Second, do all the practice questions for all the quizzes.
  - Third, go through all the suggested homework assignments.
  - Fourth, go over the lecture notes.
  - Fifth, read the book.
- These suggestions are in order of importance!!! If you don't have time to do all, then start at the top, and stop when you run out of time. However, definitely do "First".

Examples of things you need to know:

- Degrees of freedom and the ideal gas law.
- Heat transfer.
- Macroscopic & microscopic states
- PV diagrams
- Reversible vs irreversible processes
- Latent heat, phase transitions
- Pumping water from wells and alike

How do degrees of freedom affect internal energy of an ideal gas?

$$\langle E_{internal} \rangle = f/2\ kT$$

E.g. You have a mono-atomic and a di-atomic gas at high enough temperature to excite rotational degrees of the di-atomic gas. What's the ratio of average velocity for the two gases assuming their masses and temperatures are the same ? What about the ratio of specific heats ?

Example problem

A gas is initially at (18Pa, 10 cubic meter) and expands to (26 Pa, 15 cubic meter). The minimum amount of pressure the gas can be under is 7Pa, and the maximum pressure is 50Pa. Find the minimum amount of work that can be done by the gas in going from initial state to final state.

An ideal gas follows clockwise a circular path in the PV diagram.

Does the gas do work in the process?

Another Example

- A system goes through the following reversible transitions to arrive at its starting point in the PV diagram:
  - Isothermal expansion
  - Followed by Isobaric compression
  - Followed by adiabatic compression
- Is this an engine or a fridge?

Example Problem

The entropy of a system increases via an irreversible process due to a fixed amount of heat exchange.
Does it increase more or less for a higher temperature system?
And does the increase in entropy increase or decrease the ability of the system to do work?

$$\Delta s = \int \frac{dQ}{T}$$

An increase of entropy decreases the amount of energy available to do work. Recall mixing of fluids.

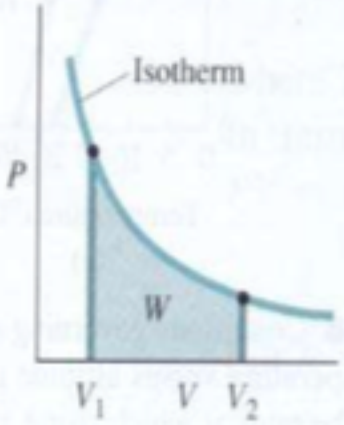
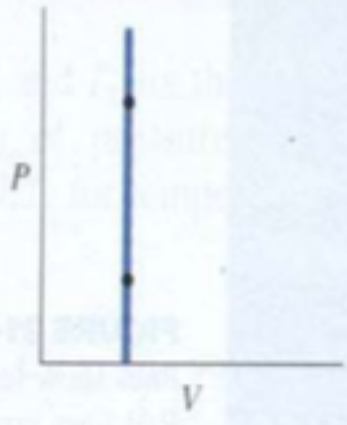
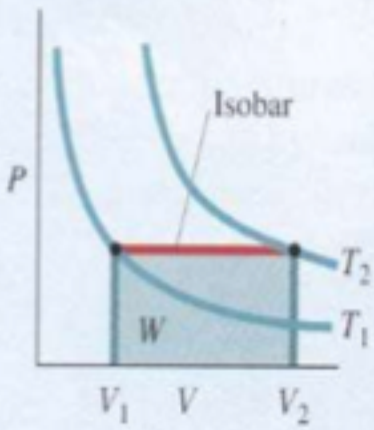
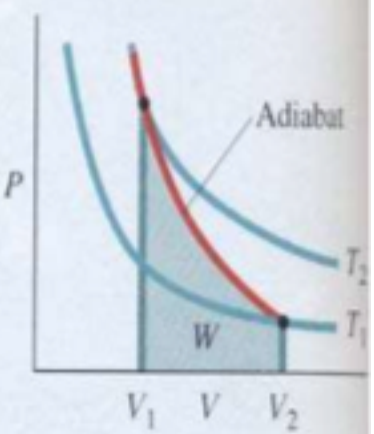
1st Law of Thermodynamics

$$dU = dQ - W$$

It's simple energy conservation. Change in internal energy of the gas (U) must be balanced in the heat you put in minus the work the gas does.

4 Processes

TABLE 21-1 *Ideal Gas Processes*

	ISOTHERMAL	CONSTANT-VOLUME	ISOBARIC	ADIABATIC
PV diagram				
Defining characteristic	T = constant	V = constant	P = constant	$Q = 0$
First law	$Q = W$	$Q = \Delta U$	$Q = \Delta U + W$	$\Delta U = -W$
Work done by gas	$W = nRT \ln\left(\frac{V_2}{V_1}\right)$	0	$W = P(V_2 - V_1)$	$W = \frac{P_1 V_1 - P_2 V_2}{\gamma - 1}$
Other relations	PV = constant	$Q = nC_V \Delta T$	$Q = nC_P \Delta T$ $C_P = C_V + R$	PV^γ = constant $TV^{\gamma-1}$ = constant

Example Questions

- How long does it take for a pot with 1kg of ice at -10 degree Celsius to boil dry when put in a 1kW Microwave Oven.

$$\Delta Q_{heating} = mc\Delta T$$

$$\Delta Q_{boiling} = mL_v$$

Etc. etc etc

Example problems

Water is pumped out of a well at 2m/s through a 9cm diameter hose. The well is 30feet deep. What power is required for the pump?

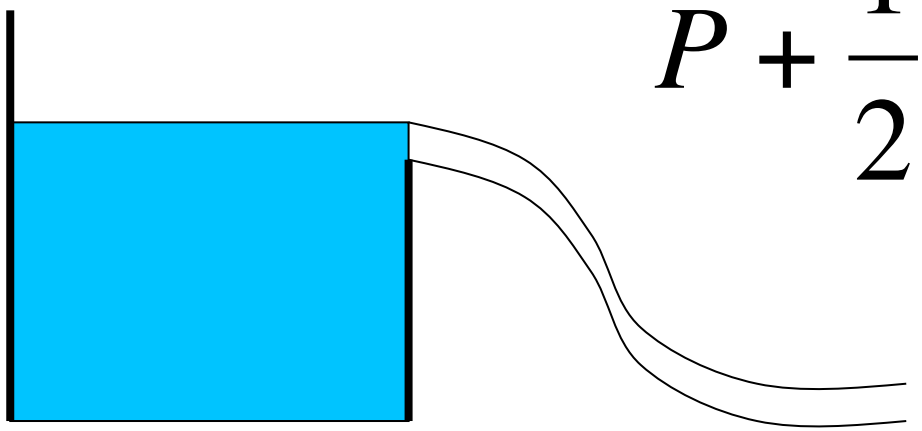
$$E = \rho V g h = \left(\rho A g h\right) y$$

$$Power = \frac{dE}{dt} = \left(\rho A g h\right) \frac{dy}{dt}$$

$$Power = \left(\rho A g h\right) v = 1141 W$$

Use of Bernoulli

Assume you have water flowing out of a hole at the top of a 10m tank. What's the velocity the water reaches when it comes to the bottom?



$$P + \frac{1}{2}\rho\, v^2 + \rho g h = const$$

v = ???

… another …

- Consider a tank of water with 24cm diameter filled with water to a height of 40cm. Consider a very small hole at height 20cm from the bottom. Find the speed at which the water exits the tank through the hole.

$$P + \frac{1}{2}\rho\, v^2 + \rho g h = const$$

… and another example …

- A water tank is filled to a depth of 10m and the tank bottom is 20m above ground. What water pressure is present in a hose 2cm in diameter at ground level? The hose is attached on one end to the bottom of the tank. The density of water is 1000kg per cubic meter.

$$P + \frac{1}{2}\rho\, v^2 + \rho g h = const$$

More examples tomorrow …

- Conditions for various interference effects
- Diffraction limit
- Optical imaging and its properties
- Mirrors and lenses
- Refraction & total internal reflection
- Doppler effect
- Intensity vs distance for spherical waves
- Standing waves at open and fixed boundary cond.
- Polarization of light
- Radiation pressure

What's a wave pulse?

A wave pulse is a superposition of many frequencies that
leads to a wave form that is localized in space rather than periodic.