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Ground Rules for Test

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Test questions will drawn from:

- Lecture notes
- Examples in the Book(s) (see below)
- Homework Problems
- Practice exam

Real questions will be modified yet similar

Suggested Books

Krane	ch 10	
Fishbane	ch 17	sec 1-3
	18	3-5,7
	19	1-3
	20	all

If you don't have a copy, buy or borrow one, there are lots of copies around.

How I would study (having already read the relevant parts of the books)

- make sure I can do homework problems
- make sure I cando the simpler examples from class (exam only 1 hr long)
- make sure I can do examples from the books

⇒ never hurts to look at problems at the back of chapters, one may catch your fancy or stimulate your brain

⇒ Read notes

You guy can actually look up examples on the web. If you haven't tried, this can be very useful.

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Error Study Sheet

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given a function with independent variables

ex $D = \frac{ab^2}{c}$ $\quad \sigma_D^2 = \left(\frac{\partial D}{\partial a}\right)^2 \sigma_a^2 + \left(\frac{\partial D}{\partial b}\right)^2 \sigma_b^2 + \left(\frac{\partial D}{\partial c}\right) \sigma_c^2$

if these variables are related to eachother though

$$\sigma_D^2 = \left(\frac{\partial D}{\partial a}\right)^2 \sigma_a^2 + \left(\frac{\partial D}{\partial b}\right)^2 \sigma_b^2 + \left(\frac{\partial D}{\partial c}\right)^2 \sigma_c^2 + 2\left(\frac{\partial D}{\partial a}\right)\left(\frac{\partial D}{\partial b}\right) \mathrm{cov}(a,b)$$
$$+ 2\left(\frac{\partial D}{\partial a}\right)\left(\frac{\partial D}{\partial c}\right) \mathrm{cov}(a,c)$$
$$+ 2\left(\frac{\partial D}{\partial b}\right)\left(\frac{\partial D}{\partial c}\right) \mathrm{cov}(b,c)$$

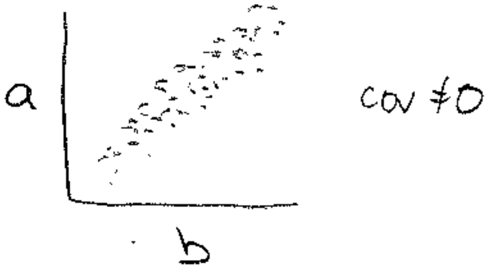
$\sigma_D^2 = \langle (D - \bar{D})^2 \rangle$

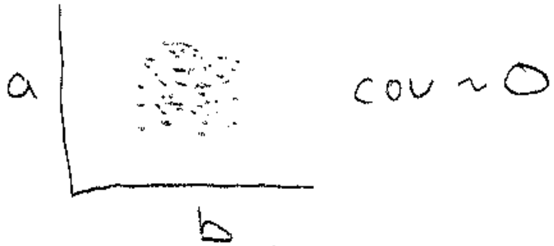
$\sigma_A^2 = \langle (a - \bar{a})^2 \rangle$, $\sigma_B^2 = \langle (b - \bar{b})^2 \rangle$

$\sigma_C^2 = \langle (c - \bar{c})^2 \rangle$

$\mathrm{cov}(b,c) = \langle (b - \bar{b})(c - \bar{c}) \rangle$

$\mathrm{cov}(a,b) = \langle (a - \bar{a})(b - \bar{b}) \rangle$, $\mathrm{cov}(a,c) = \langle (a - \bar{a})(c - \bar{c}) \rangle$





Fitting data $\quad \chi^2 = \sum_{\substack{\text{data}\\ \text{points}}} \frac{(y_i - f(x_i))^2}{\sigma_i^2}$

χ^2 is roughly = # points − # variables you fit to

applications

weighted average $\quad \frac{\sum \frac{x_i}{\sigma_i^2}}{\sum \frac{1}{\sigma_i^2}} = \bar{x} \qquad \sigma_{\bar{x}}^2 = \frac{1}{\sum \frac{1}{\sigma_i^2}}$

error in counting $\sqrt{N}$

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Thermo Study Sheet

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Played with ideal gas

$$\Delta E_{INT} = \underbrace{\Delta Q}_{\text{heat flow into system}} - W_{\text{done by gas}}$$

Ideal, monatomic gas

$$\Delta E_{INT} = \frac{3}{2} N k_B T$$

$$PV = N k_B T$$

entropy

$$\Delta S = \int \frac{dQ}{T} = \int \frac{\Delta E_{INT}}{T} + \int \frac{dW}{T}$$

Processes (reversible if we can get back with $\Delta S = 0$)

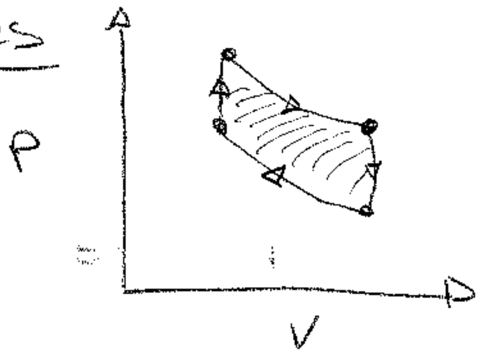
isobaric - constant pressure $\Delta Q = C_p \Delta T$, $W = P \Delta V$, $\Delta E_{INT} = \Delta Q - W$

isochoric constant volume $\Delta Q = C_v \Delta T = \Delta E_{INT}$ $W = 0$

Adiabatic no heat flow (constant entropy) $\Delta Q = 0$ $\Delta E_{INT} = -W$ $P_1 V_1^{\gamma} = P_2 V_2^{\gamma}$ $\gamma = \frac{C_p}{C_v}$

isothermal constant temperature $\Delta E_{INT} = 0$ $Q = W$ $W = N k_B T \ln\left(\frac{V_F}{V_I}\right)$

Engines



Cyclic engine w/ reversible processes

$\Delta E_{INT} = 0$ whole
$\Delta S_{gas} = 0$ cycle

$$W = \underset{\text{heat put in}}{Q_H} - \underset{\text{heat taken away}}{|Q_C|}$$

$$\varepsilon = 1 - \frac{|Q_C|}{Q_H} = \frac{W}{Q_H}$$

Perfect cycle $\varepsilon = 1 - \frac{T_C}{T_H}$, $\varepsilon > 1$

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Stat mech Study sheet

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- Can learn about properties of a system by considering it's possible arangements

- For an idealized gas or solid, there is an arrangement of particles that is most likely at thermal equilibrium

$$S = Nk_B \ln g \text{ in general, and } Nk_B \ln W = S_{max}$$

# of different ways to arrange particles or quanta
- a sum over many different arrangements

one macrostate (the most likely arrangement)

- We considered small changes in W and found that we could relate different energy levels separated by ΔE

$$N_{\varepsilon+\Delta\varepsilon} = N_\varepsilon e^{-\Delta\varepsilon/k_BT}$$

where $N_\varepsilon \propto e^{\varepsilon/k_BT}$ {The number of particles in a state of energy ε}

& we found information about a system of particles by considering expectation values

$$\langle A \rangle = \sum_{\text{all particles}} P(A)\, N(A)$$

number of states with A

probability to have A

⇒ we usually didn't bother with getting P(A) in its proper form, we "normalized"

$$\langle A \rangle = \frac{1}{N_{particles}} \sum F(A)\, N(A)$$

some function allowing us to relate onestate to another

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contrast Einstein Solid ⟷ Black body

one frequency | many frequencys

distribution due to how quanta are split up as levels

(distribution due to how quanta are split up as levels) (# ways to get the quant

$$\frac{\langle E_{tot}\rangle}{\#\text{oscillators}} = \underset{\text{energy of quanta}}{\hbar\omega}\underbrace{\left(\frac{1}{e^{\hbar\omega/k_BT}-1}\right)}_{\substack{\#\text{ photons of}\\ \text{particular frequency}}}$$

$$\frac{E_{tot}}{V} = \int_0^{\infty}\frac{\overbrace{\hbar w}^{\text{energy of quanta}}}{\pi^2 c^3}\left(\frac{1}{e^{\hbar\omega/k_BT}-1}\right)\underbrace{\omega^2 d}_{\substack{\text{number of states}\\ \text{with quanta}}}$$

"Black body solid"
need to limit the number of states due to limited number of oscillators

$$3N = (\text{Factor})\int_0^{n_D} n^2\,dn \Rightarrow \int_0^{n_D} \quad dn$$

Different Distributions

$f_{MB}(\varepsilon) = Ae^{-\varepsilon/k_BT}$ < classical particle

$f_{BE}(\varepsilon) = \frac{1}{Ae^{\varepsilon/k_BT}-1}$ ⟸ Bose-Einstein (

$f_{FD}(\varepsilon) = \frac{1}{Ae^{\varepsilon/k_BT}+1}$ ⟸ fermi-Dirac (White Dwarf)