Physics is about much more than equations---it is about ideas !!! Mathematics is the language that allows us to express those ideas in a compact, precise form. Some ideas require both the language of mathematics and the language of people to express them---quantum mechanics certainly does. Other ideas can be expressed using only words and pictures---because people intuitively understand the math.

I want you to understand the physics of the experiments, which to me means being able to express it in words, in pictures, and in equations. Rutherford said that if you really understand something you should be able to explain it to your grandmother. I am not asking you to explain the physics in a way that your grandmother would understand it. Just explain it so that I know that you understand it.

For each of the topics on the next page, write clear, concise, physical descriptions that demonstrate you really understand the important the physics of the experiments. You should be able to do this in a few sentences to a paragraph for each topic.

Explain the physics for each topic in your own words. You do not have to write a perfect essay on each topic, but do write enough to convince me that you really do understand the topic. Make sure to include any important pictures, graphs, and equations.

Try to write down, or draw, three or four important things for each topic.

All I want is for you to understand the physics. I am asking you to write things down because I know you will learn more that way.

If you would rather make a video or a video game, or to write a play, a poem, or a song, No Problem!
Just make sure that your opera magna show me that you understand the physics.

	Nuclear Magnetic Resonance 1
1	precession
2	Larmor frequency
3	resonant excitation
4	the real and imaginary components of response
5	the energy level splitting for spin 1/2
6	the number of spins (protons) in 1 mL of water at 300 K
7	the number of excess spins in 1 mL of water at 300 K and 2 kGauss
8	the proton spin crisis
9	the quark composition of the proton
10	the quark composition of the neutron
11	the magnetic moment of the proton
12	the magnetic moment of the electron
13	the magnetic moment of the neutron
14	the magnetic moment of F-19
15	the nuclear shell structure of F-19

	Nuclear Magnetic Resonance 2
1	90 degree pulse
2	180 degree pulse
3	decoherence
4	T1
5	T2
6	spin echo
7	receiver
8	mixer
9	detector
10	heterodyning
11	Fourier transform NMR
12	lab frame
13	rotating frame
14	Bloch sphere
15	diffusion
16	MRI
17	fMRI

	Diffraction
1	the real lattice vs the reciprocal lattice
2	Explain how reciprocal space is related to momentum space
3	the motif---aka the basis, aka the contents of the unit cell
4	the effect produced by changing the size of the real lattice
5	the effect produced by changing the size of the motif
6	the systematic absences for fcc crystals
7	the Ewald sphere
8	The First Born approximation
9	the scattering amplitude
10	the scattering intensity
11	the scattering potential for electrons
12	the scattering potential for optical photons
13	the scattering potential for x-rays
14	the convolution theorem in general
15	the convolution theorem for a HiFi amplifier
16	the convolution theorem for crystallography
17	ZOLZ, FOLZ, SOLZ

The learning goals for the electron diffraction part of the lab are:

(1) To understand how to calculate d-spacings for fcc and hexagonal crystals.

(2) To understand systematic absences aka allowed reflections

So, for your measured aluminum and graphite diffraction rings:

(1) Show that your measured d-spacings agree with the known d-spacings

(2) Show that your measured reflections agree with the known allowed reflections

	Noise
1	thermal noise
2	shot noise
3	blackbody radiation
4	equipartition theorem
5	Boltzmann constant
6	electron charge
7	white noise
8	pink noise
9	blue noise
10	brown noise
11	thermal noise frequency cutoff
12	shot noise frequency cutoff
13	1/f noise
14	photon noise
15	quantum efficiency
16	Gaussian noise
17	the universal origin of shot noise and thermal noise

	Surface Plasmon Resonance
1	dispersions relation in general
2	the dispersion relation for light in vacuum
3	the dispersion relation for light in a metal
4	the dispersion relation for light in a dielectric
5	the dispersion relation for an electron in vacuum
6	the dispersion relation for a proton in vacuum
7	the dispersion relation for a neutron in vacuum
8	the dispersion relation for a surface plasmon
9	the dispersion relation for a bulk plasmon
10	evanescent waves and virtual particles
11	the complex dielectric function in general
12	the complex wavevector in general
13	the complex refractive index function in general
14	the complex dielectric function in a metal
15	the complex dielectric function in a dielectric
16	the complex wavevector in a metal
17	the complex wavevector in a dielectric
18	the complex refractive index function in a metal
19	the complex refractive index function in a dielectric