Chemistry 20B Syllabus: Winter 2017

http://www.nano.ucla.edu/_psw/chem20bw17.html

Lectures: **MWF 10-10^{50} AM Young Hall CS50 (Weiss)**
MWF 11-11^{50} AM Young Hall CS76 (Finck)
MWF 12-12^{50} PM Young Hall CS24 (Weiss)

Instructor: Prof. Paul S. Weiss (Dr. Ben Finck lectures Section 4)

Textbook: *Principles of Modern Chemistry*, 8th edition, Oxtoby, Gillis, & Butler

Discussion: Location & time for your Section on MyUCLA

Lecture Dates:		**Topic:**	**Book Chapter(s):**
Week 1	9-13 Jan	Class Introduction, Ideal Gas Law, Kinetic Theory of Gases, Intermolecular Forces, Non-Ideal Gases, Energy Scales, and Spectroscopies	Ch. 9/20
Week 2	16 Jan	No lecture – Martin Luther King Jr. Day – Holiday	
	18-20 Jan	Bulk Properties of Gases/Liquids/Solids, Phase Transitions, Phase Diagrams	Ch. 10
Week 3	23-27 Jan	Solutions, Acid-Base Titrations, Redox Titrations, Equilibrium	Ch. 11/14
Week 4	30 Jan-3 Feb	Internal Energy, Work, Enthalpy, Entropy, Gibb's Free Energy	Ch. 12/13
Week 5	6-10 Feb	Equilibrium, Acid-Base Equilibria, Buffers	Ch. 15
	Tues 7 Feb	7-9 PM Midterm 1	
Week 6	13-17 Feb	Solubility and Precipitation, Electrochemistry, Cell Potentials and Gibbs Free Energy, Batteries	Ch. 16/17
Week 7	Mon 20 Feb	No Lecture – Presidents' Day - Holiday	
	22-24 Feb	Electrochemistry Continued.	Ch. 17
Week 8	27 Feb-3 Mar	Band Theory of Conduction, Semiconductors Semimetals, Direct Band-Gap vs. Indirect Band-Gap, Spectroscopies	Ch. 22
	Thur 2 Mar	7-9 PM Midterm 2	
Week 9	6-10 Mar	Chemical Kinetics, Rate Laws, Mechanisms, Catalysts	Ch. 18
Week 10	13-17 Mar	Nuclear Chemistry	Ch. 19

Learning in Chem 20B
This is an exciting course for many reasons. We are able to cover many of the highlights of chemistry in a relatively informal way. This introduction is meant to guide you through many future years of scientific thinking and discussion, citizenship, and possibly even more chemistry.

Much of what you learn, you will learn on your own or from each other. This will allow us to have a higher level of discussion in class. This will require work on your part. Please be prepared for it and budget the time for it. Anticipate that **the lectures, the readings, and the homeworks will be *complementary* rather than overlapping. You will be responsible for the material from *all* of these sources**. Similarly, your participation in class is required both for discussions and for the education of your classmates, TAs, and professor.

Grading
Midterms: at 20% each
5 Assessments in section 10% total: at 2% each
Final 25%
Homework 25% total = 5% creative problems + 10% graded problems + 5% submitted + 5% reading memos

Homework is due *each* lecture and will be returned in discussion section or Monday lecture.
Do the reading and homework in *advance* of lecture to prepare for a higher level discussion in class.
In addition to the assigned problem, homework may also require you to write and answer a problem that captures a key concept from the previous topic or lecture. These will always be graded. The best problems will be assigned to future classes, and your biography (and "vintage") will be given.
Check the syllabus frequently, as we will update readings, homeworks, and other links.
(When the next lecture date is in green, those assignments are finalized.)

Readings from the textbook will be assigned for material each lecture. In addition to the assigned readings, "reading memos" on the assigned readings will be collected on Fridays each week with homework BEFORE the topics are covered in lecture. A reading memo is NOT a summary of the text. Your reading memos should include your questions, comments, and annotations of the reading assignments The intention of reading memos is to encourage you to approach assigned readings from a critical and analytical perspective. Furthermore, they will inform the instructor of concepts which are particularly confusing for students BEFORE they are discussed in class.

Reading memos will be graded based on completion and timely submission. The only length requirement for a reading memo is that a single (1) question/comment is *in*sufficient.

Note that all material discussed in assigned readings is considered testable material, even if it is not explicitly discussed in lecture. The lectures, the readings, and the homework assignments are designed to be complementary.

Notes on Assessments: Assessments will be given during your discussion section. They are designed to be a check of your mastery of the content as well as a mechanism for feedback.

Notes on Exams: No notes, calculators, computers, phones, smart watches, connected devices, etc. are allowed during exams. A periodic table and needed formulas and constants will be provided. Exam regrade requests will be considered for one week after the exam is returned and the entire exam paper will be regraded. Please coordinate special exam requirements with your TA at the beginning of the quarter (*i.e.*, during the first week). Makeup exams, when necessary because of exams missed with approved excuses, will be conducted as private oral exams with Prof. Weiss.

Final exam date will be released at a later time.

Letter grades will be determined based on student performance after the final exam is given.

Office Hours
Prof. Paul Weiss, in 3041 Young Hall
Tuesday 10^{30}-11^{30} AM and Thursday 2^{30}-3^{30} PM
(*NB*- On crowded days, we may move to 3056 Young Hall)
Prof. Weiss is often available on iChat/AIM/WeChat/etc. as PSWeiss
TA Office Hours – announced in sections and on course web site: http://bit.ly/chem20Bw17

Reading and homework
(Updated frequently, not finalized until the upcoming lecture date is in green)

Please complete readings prior to coming to lecture.
Turn in homework in lecture, in the folder for your section.
If you are not going to make it to lecture, email your homework to your TA *prior* to lecture.
Late homework will not be accepted without a TA-approved excuse.

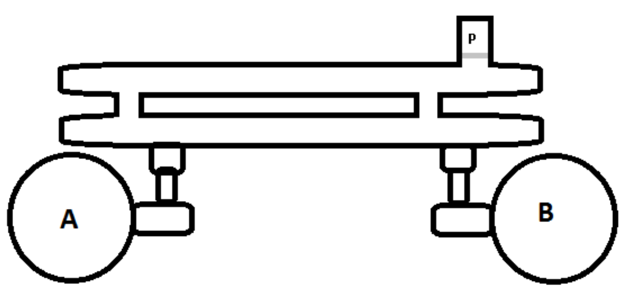
All readings will come from *Principles of Modern Chemistry*, by Oxtoby, Willis, & Campion, 8th edition, unless otherwise specified.
Older editions may also be used, however the chapters and problems **will vary**, so be sure to get the correct readings and problems from the current edition for assignments.

For **Lecture 1, Monday 9 January**
Review Chapters 1-8

For **Lecture 2, Wednesday 11 January**
Reading:
9.1 The Chemistry of Gases
9.2 Pressure and Temperature of Gases
9.3 The Ideal Gas Law
9.4 Mixture of Gases

Problems:
9.18, 9.20, 9.64, 9.66

Many experiments use gas manifolds to transfer gases from one reaction vessel to another. Knowing the volume of such manifolds can be crucial. Bulb A was filled with 540. mL of N_2 gas. When opened to the glass manifold, the pressure was allowed to equilibrate and the new pressure (read at location P) was 295 Torr. Next, an empty 549 mL bulb labeled B was opened to the manifold. The new pressure read was 228 Torr. What is the available volume in the glass manifold assuming ideal gas law?



Create and solve your own original problem that captures a key concept from the previous topic or lecture. (The best problems will be assigned to future classes with your biography.)

Additional assignment:
Choose your favorite energy unit and learn the conversions (to two significant figures) to:
eV, kcal/mole, kJ/mole, J, cm^{-1} (one of the first three would likely be most useful)

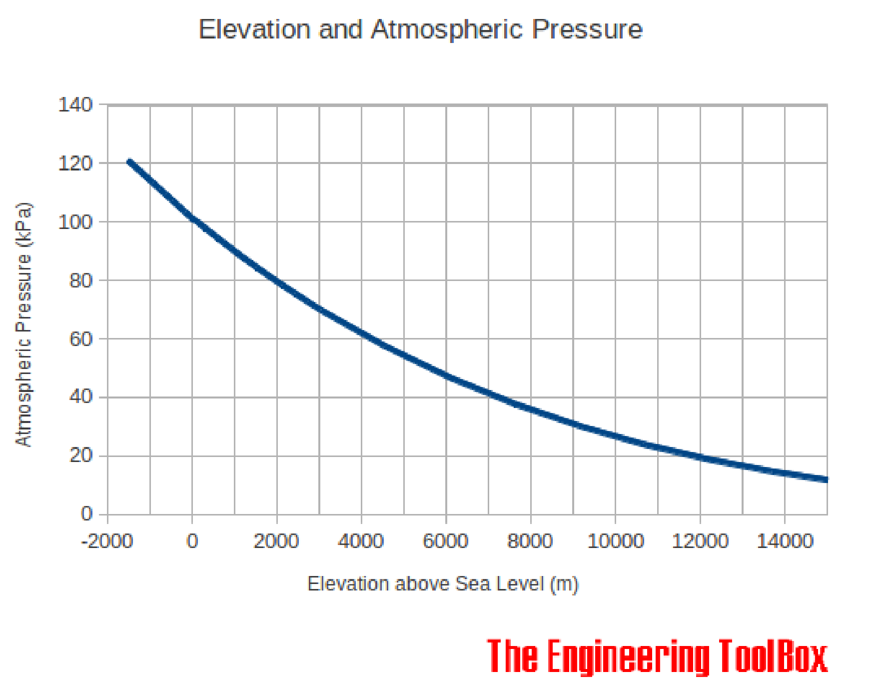
For fun (not required):
http://bit.ly/1St91NM
A prank in the periodic table from a great UCLA chemistry alumnus

Deflategate, the New England Patriots, and the Ideal Gas Law, from Chad Orzel
http://bit.ly/1Ou1M6N

For **Lecture 3, Friday 13 January**
Reading:
9.5 Kinetic Theory of Gases
9.6 Real Gases
10.1 Bulk Properties of Gases, Liquids, and Solids: Molecular Interpretation
10.2 Intermolecular Forces: Origins in Molecular Structure

Problems:
9.34, 9.40, 9.44, 9.87

After a pleasant weekend on the shores of Lake Tahoe (elevation: 1900 m), Leroy travels back down the Sierra Nevada to his hometown in Folsom, California (elevation: 70 m). During his trip, Leroy feels his eardrum bulging inward to compensate for pressure. Given that the volume of the inner ear is approximately 225.0 µL in the neutral starting position (i.e. no eardrum bulging), what is the volume of Leroy's inner ear when he arrives in Folsom. Assume constant temperature, and use the data below to guide your calculations.



Created by Matthew Ye in our Winter 2016 class: Matthew is a second year biophysics major from Toronto, Canada. In high school, he enjoyed using chemistry to create “energetic chemical reactions” in his friend's garage. Since then, he has been involved in research at Stanford University and currently works in Professor Weiss's lab. In his free time, he enjoys distance running and hopes to run his first marathon in the summer.

Create and solve your own original problem that captures a key concept from the previous topic or lecture.

(Reading memos)

Martin Luther King Jr. Holiday Monday 16 January

For **Lecture 4, Wednesday 18 January**
Reading:
10.3 Intermolecular Forces in Liquids
10.4 Phase Equilibrium
10.5 Phase Transitions
10.6 Phase Diagrams
Take a look at mass spectrometry and mass spectrometers in chemical analysis (find a source – if you locate a particularly good one, alert your TA directly or in your reading memo.)

Problems:
10.8, 10.15, 10.20, 10.34, 10.48

Create and solve your own original problem that captures a key concept from the previous topic or lecture.

For fun (not required):
Scientific American discussion of North Korea’s test of what might not have been a hydrogen bomb:
http://bit.ly/1OSiHSD

Quanta (http://bit.ly/1mLf04f) article on George Church’s left-handed world (more on George later this quarter):
http://bit.ly/1mLf04f

A chemistry song from my friend and colleague, Dr. (Col. Hon.) Chuck Martin at the University of Florida
http://bit.ly/1mzngop
NB- Paul was in the audience at the club with Prof. Martin’s students for this performance after giving a talk in his department.

Ice skating text box, describing why the reduction in friction when skating is *not* due to pressure-induced melting.
http://bit.ly/1N1WbiD

Thursday 19 January – Prof. has no office hours as he is in Washington, DC

For **Lecture 5, Friday 20 January**
Reading:
11.1 Composition of Solutions
11.2 Nature of Dissolved Species
11.3 Reaction Stoichiometry in Solutions: Acid–Base Titrations

Problems:
11.3, 11.9, 11.14, 11.26
Create and solve your own original problem that captures a key concept from the previous topic or lecture.

(Reading memos)

1^{45}-2^{45} PM Special office hours PSW in 3041 Young Hall

For **Lecture 6, Monday 23 January**
Reading:
11.4 Reaction Stoichiometry in Solutions: Oxidation–Reduction Titrations
11.5 Phase Equilibrium in Solutions: Nonvolatile Solutes
11.6 Phase Equilibrium in Solutions: Volatile Solutes

Problems:
11.28, 11.34, 11.40, 11.58, 11.78

Assign the formal oxidation state of each atom in these iron oxides and hydroxides:
FeO Fe_3O_4 Fe_2O_3 Fe_4O_5 $Fe(OH)_2$ $Fe(OH)_3$
Which have mixed valence?

For fun:
4 PM CNSI Auditorium
An amazing talk by Prof. Kim Prather of UCSD and Scripps Institute of Oceanography
http://bit.ly/KP2UCLA

For **Lecture 7, Wednesday 25 January**
Reading:
14.1 The Nature of Chemical Equilibrium
14.2 The empirical Law of Mass Action
14.3 Thermodynamic Description of the Equilibrium State

14.4 The Law of Mass Action for Related and Simultaneous Equilibria

Problems:
14.10, 14.16, 14.18, 14.35
Create and solve your own original problem that captures a key concept from the previous topic or lecture.
Extra credit: If you came to Prof. Kim Prather's lecture, write a few sentences about what you learned.

For **Lecture 8, Friday 27 January**
Reading:
14.5 Equilibrium Calculations for Gas-Phase and Heterogeneous Reactions
14.6 The Direction of Change in Chemical Reactions: Empirical Description
14.7 The Direction of Change in Chemical Reactions: Thermodynamic Explanation
14.8 Distribution of a Single Species between Immiscible Phases: Extraction and Separation Processes

Problems:
14.20, 14.22, 14.58, 14.73
Create and solve your own original problem that captures a key concept from the previous topic or lecture

(Reading memos)

For **Lecture 9, Monday 30 January**
Reading:
12.1 Systems, States, and Processes
12.2 The First Law of Thermodynamics: Internal Energy, Work, and Heat
12.3 Heat Capacity, Calorimetry, and Enthalpy
12.4 The First Law and Ideal Gas Processes

Problems:
12.3, 12.10, 12.14, 12.15

For **Lecture 10, Wednesday 1 February**
Reading:
12.5 Molecular Contributions to Internal Energy and Heat Capacity
12.6 Thermochemistry
12.7 Reversible Processes in Ideal Gases
12.8 Distribution of Energy among Molecules
Read the wikipedia page on heat capacity, which is free to use a little calculus, and gives a better explanation, in my opinion
https://en.wikipedia.org/wiki/Heat_capacity

Problems:
12.26, 12.42, 12.56, 12.63

For the reaction
$2Cu^{+} + Zn(s) \rightarrow Zn^{2+} + 2Cu(s)$
Calculate $E°_{cell}$, $\Delta G°$, and K_{eq}

Create and solve your own original problem that captures a key concept from the previous topic or lecture.

For **Lecture 11, Friday 3 February**
Reading:
13.1 The Nature of Spontaneous Processes
13.2 Entropy and Spontaneity: A Molecular Statistical Interpretation
13.3 Entropy and Heat: Macroscopic Basis of the Second Law of Thermodynamics
13.4 Entropy Changes in Reversible Processes

Problems:
13.2, 13.6, 13.10, 13.16
Create and solve your own original problem that captures a key concept from the previous topic or lecture.

(Reading memos)

For exam preparation, see the recap slides and selected others, here:
http://bit.ly/20B17recaps
Practice exams are at the end of this file.

Saturday 4 February, 2-4 PM in CS50

Optional exam #1 review session with all our TAs

For **Lecture 12, Monday 6 February**
Reading:
13.5 Entropy Changes and Spontaneity
13.6 The Third Law of Thermodynamics
13.7 The Gibbs Free Energy
13.8 Carnot Cycles, Efficiency, and Entropy

Problems:
13.18, 13.24, 13.25, 13.34, 13.40

Tuesday 7 February 7-9 PM Midterm #1
If you are in the 10 AM Lecture (Section 2, all) in Moore 100
If you are in the 12 noon Lecture:
Sections 3A-D in Physics & Astronomy Building 1425
Sections 3E-I Lakretz 110

Average = 75, Standard Deviation = 17
4 students at 104. 21 students ≥ 100

For **Lecture 13, Wednesday 8 February**
Reading:
15.1 Classification of Acids and Bases
15.2 Properties of Acids and Bases in Aqueous Solutions
15.3 Acid and Base Strength
15.4 Equilibria Involving Weak Acids and Bases

Problems: Consider starting on Friday's double assignment

For **Lecture 14, Friday 10 February**
Reading:
15.5 Buffer Solutions
15.6 Acid-Base Titration Curves
15.7 Polyprotic Acids

Problems:
15.1, 15.8, 15.17, 15.24, 15.38
15.46, 15.48, 15.52, 15.58, 15.66
Create and solve your own original problem that captures a key concept from the previous topic or lecture.

(Reading memos)

Optional:
4 PM See Prof. Cathy Murphy of the University of Illinois and Urbana-Champaign speak in CS76
Gold Nanocrystals: Physics, Chemistry, Biology, and Ecology
http://bit.ly/CMurphyUCLA

Here is our friend Millie Dresselhaus from MIT in an ad from GE:
http://bit.ly/MillieGE
and in a Conversation that we had:
http://bit.ly/MillieD
I am afraid that Millie passed away shortly after this post.

For **Lecture 15, Monday Feb. 13**
Reading:
16.1 The Nature of Solubility Equilibria
16.2 Ionic Equilibria between Solids and Solutions
16.3 Precipitation and the Solubility Product

Problems:
16.3, 16.11, 16.20, 16.24

Tuesday Feb 14
Happy Valentine's Day!

For **Lecture 16, Wednesday Feb 15**
Reading:
16.4 The Effects of pH on Solubility
16.5 Complex Ions and Solubility
16.6 A Deeper Look… Selective Precipitation of Ions

Problems:
16.32, 16.33, 16.37, 16.39, 16.54
Create and solve your own original problem that captures a key concept from the previous topic or lecture (making up for the one we skipped the day after the exam).

Optional problem:
For 1 M, 0.5 M, and 0.1 M acetic acid (each), at equilibrium:
What is the acetate ion concentration?
What is the pH?
What is the fraction dissociation?

For **Lecture 17, Friday Feb 17**
Reading:
17.1 Electrochemical Cells
17.2 Cell Potentials and the Gibbs Free Energy
17.3 Concentrations Effects and the Nernst Equation

Problems:
17.8, 17.24, 17.27
Create and solve your own original problem that captures a key concept from the previous topic or lecture.

(Reading memos)

Presidents Day Holiday Monday 20 February

For **Lecture 18, Wednesday Feb 22**
Reading:
17.4 Molecular Electrochemistry, *Connection to Biology* : ECL in Clinical Assays
and *Connection to Energy*: Solar Energy Conversion
17.5 Batteries and Fuel Cells

Problems:
17.45, 17.53, 17.55

Name one vitamin, draw its chemical structure, and briefly describe one aspect of what it does in terms of biological function (*e.g.*, if it is part of a particular enzyme). Can you overdose on it (*i.e.*, is it fat-soluble?)?

Name one neurotransmitter, draw its chemical structure, and briefly describe one aspect of what it does in our brains (*e.g.*, relation to behavior, mood, etc.)

If you did not cover or do not remember, crystal field theory and metal ion complexes, review those sections.

If you have the time, read ahead in Chapter 22 on the electrical properties and excitations in metals and semiconductors. Some of the issues are now covered in the Recaps.

Optional (for fun)
4 PM Dan Nocera, Harvard giving the Fred Hawthorne Lecture in the CNSI Auditorium
http://bit.ly/ArtLeafDN17

For **Lecture 19, Friday Feb 24**
Reading:
22.6 Band Theory of Conduction
22.7 Semiconductors
17.6 Corrosion and Corrosion Protection
17.7 Electrometallurgy
17.8 A Deeper Look: Electrolysis of Water and Aqueous Solutions

Problems:
17.62, 17.72

Making a battery out of nickel and iron that proceeds by the following reaction:
$Ni^{2+}(aq) + Fe(s) \rightarrow Fe^{2+}(aq) + Ni(s)$

What are ΔG and E_{cell} initially and after running the battery until the concentrations of the metal ions in solution are: $[Ni^{+2}] = 0.050$ M and $[Fe^{+2}] = 1.0$ M.

You attempt to "recharge" your battery by adding Ni^{+2} until it is 0.5 M (ignore any volume change due to the addition). What are the new ΔG and E_{cell}?

Create and solve your own original problem that captures a key concept from any time in the course.

(Reading memos)

For **Lecture 20, Monday Feb 27** – **Kris Barr lecturing**
Reading:
22.1 Minerals: Naturally Occurring Inorganic Materials
22.2 Properties of Ceramics
22.3 Silicate Ceramics

Problems:
22.4, 22.7, 22.9, 22.12

7-9 PM Dodd 147
Review Session

Optional reading on **Zone Refining** and just for fun:
https://en.wikipedia.org/wiki/Zone_melting

Tuesday Feb 28
No morning office hours.
Special office hours 3^{30}-4^{30} PM

For **Lecture 21, Wednesday March 1**
Reading:
22.4 Nonsilicate Ceramics
22.5 Electrical Conduction in Materials

Problems:
22.16, 22.19, 22.21, 22.25

For exam preparation, see the updated recap slides and selected others, here:
http://bit.ly/20B17recaps
Practice exams are at the end of this file.

Thursday 2 March 7-9 PM Midterm #2

CS 50 Sections 2A-2E
CS 24 Sections 2F-2L
Moore 100 Lecture 3, all sections

If you may later ask for regarding, please use a pen for the exam
Average = 79, Standard deviation = 14

For **Lecture 22, Friday 3 March**
Reading (if you did not do it last week):
22.6 Band Theory of Conduction
22.7 Semiconductors

Problems: none until Monday because of exam

For **Lecture 23, Monday 6 March**
Reading:
18.1 Rates of Chemical Reactions
18.2 Rate Laws
18.3 Reaction Mechanisms

Double Problems (because of exam)
18.4, 18.8, 18.18, 18.22, 18.23
22.28, 22.32, 22.33, 22.54, 22.56
Create and solve your own original problem that captures a key concept from the previous topic or lecture.

(Reading memos)

For **Lecture 24, Wednesday 8 March**
Reading:
18.4 Reaction Mechanisms and Rate
18.5 Effect of Temperature on Reaction Rates

Problems:
18.26, 18.29, 18.37, 18.40

4^{30}-5^{30} PM Special PSW office hours today

For **Lecture 25, Friday 10 March**
Reading:
18.6 Molecular Theories of Elementary Reactions
18.7 Reactions in Solution
18.8 Catalysis

Problems:

18.64, 18.68, 18.72
Create and solve your own original problem that captures a key concept from the previous topic or lecture.

(Reading memos)

For **Lecture 26, Monday 13 March**
Reading:
19.1 Mass-Energy Relationships in Nuclei
19.2 Nuclear Decay Processes
19.3 Kinetics of Radioactive Decay

Problems:
19.4, 19.9, 19.15
Create and solve your own original problem that captures a key concept from the previous topic or lecture.

For **Lecture 27, Wednesday 15 March**
Reading:
19.4 Radiation in Biology and Medicine
19.5 Nuclear Fission
19.6 Nuclear Fusion and Nucleosynthesis

Problems:
19.27, 19.31, 19.46

(Reading memos)

For **Lecture 28, Friday 17 March**
In-Class Review – please find all the slides in our Recap file:
http://bit.ly/20B17recaps

Saturday 18 March, 2-4 PM
CS 76
TA Review Session

Tuesday 21 March, 6^{30}-9^{30} PM Final Exam
CS 24 Sections 2E-2L
CS 50 Sections 2A-2D & 3A-C
CS 76 Sections 3D-3I
No calculators/watches/devices are allowed for the final exam (Tuesday).

Special office hours:
Tuesday 21 March 10^{30}-11^{30} AM & 2^{30}-3^{30} PM
Thursday 23 March 2^{30}-3^{30} PM

Make-up exam on Friday 24 March 3-6 PM, CS50, by prearrangement only.
You will need a calculator for the make-up and be sure to ask for the extra questions.