CHEM 304
SPRING 2012
EXAM 2 Review Sheet:

TOPICS: Climate change, water chemistry, and toxic substances.

SCOPE: Readings: Baird (Chapters 6, 7, 13, & small parts of 4, 10, 14, & 15) and the IPCC AR4 report. HW: #7 – #10. Lecture thru F 5/3/12, & all handouts, etc. (I would spend a lot of time with this sheet, your lecture notes, the IPCC report, and the HW assignments). The rough breakdown is: at least 1/2 "climate", about 1/3 "water", 1/6 "toxics".
There will be another essay – similar in scope to what we did for exam #1.

TERMS:

Blackbody Radiation	Wet/Dry Deposition	Run-off
Blackbody Curves	Deforestation	Precipitation
Flux	Aerosol	Henry's Law Constant (K_H)
Steady State Radiation Balance	Radiative Forcing	Aerobic Conditions
Albedo	Anthropogenic Forcing	Anaerobic Conditions
Effective (radiation) Temperature	Natural Forcing	pE
Greenhouse Warming	Positive Feedback	Oxidation number (State)
Greenhouse Gas	Negative Feedback	K_{sp}
Global Warming Potential	Ground Water	pH
Carbon Cycle	Surface water	K_a, K_b
Photsynthesis	Evaporation	Bioaccumulation
Respiraiton	Transpiration	Partition coefficient (K_{ow})
Uptake	Percolation	

CONCEPTS:

<u>Climate:</u>

• Radiation Balance: What processes occur when molecules interact (absorb) EM radiation? (UV/VIS vs. IR) What factors affect the radiation emitted by a macroscopic object – i.e. how does T affect the size and shape of a blackbody curve? What three general factors/processes affect the overall radiation balance? Effective Temperature calcs. —> why are the surface temperatures of Mars, Earth and Venus so different? Mechanism for a greenhouse effect in terms of blackbody curves, and specifically, the effect of substances that absorb outgoing IR radiation. Accounting: How does the amount of radiation exchanged by the surface and the atmosphere compare to the amount coming into either the surface or the atmosphere from the sun (directly).

• Greenhouse gases: Deciding whether a given molecule can absorb IR radiation based on its chemical formula. What two criteria are key for a substance to be considered a greenhouse gas? What sink processes must a substance be resistant to in order to have a lifetime long enough to be worth considering as a greenhouse gas? What substances absorb most of the incoming and outgoing radiation? What are the five (6 if you include ozone) most important greenhouse gases, and their sources/sinks? How have the concentrations of these substances changed over the past 100-200 years? How have human activities affected these concentrations? What are the reactions and the names of the key processes in the carbon cycle? How does the CO_2 input to the atm compare with the natural carbon cycle? What does the value of a GWP tell you about what IR wavelengths are absorbed. And how does the variation of the GWP w/ time tell you about chemical properties of a given greenhouse gas?

• Temperature histories, feedbacks, and "other" (non-chemical) climate factors: What is the overall variability in global average T over the past 100-1150 years? 1500 years? 10's to 100's of thousands of years? What are the main, underlying factors which have caused these variabilities (to the extent that they

are known)? The Vostok ice core experiment: what did they do? What data are in this core, and what do they mean? How is the core dated? Does the Vostok prove the global warming/CO2 hypothesis? Feedbacks: how do they operate (specific examples)? Which type of feedbacks stabilize climate, which de-stabilize climate? Albedo effects: How do (sulfate/nitrate) aerosols affect climate? What are their sources? How do land use changes affect albedo? How to albedo changes affect warming/forcing Solar effects: What might have the little ice age been related to? How have fluctuations in the Earth's orbit affected climate – and on what times scale? How much have solar effects contributed to recent climate change?

• The IPCC WGI AR4 (2207) Report: Changes in Climate Factors: By about what % have the main GHG's increased relative to the "pre-industrial" levels? (see Figure SPM-1) What factors have had the biggest impacts (warming and cooling)? (see Figure SMP-2) What are the chemical factors/processes that have lead to these changes? Which changes are non-chemical? Observed Changes in Climate: what things have changes in the climate systems (T obviously, but what about 2 other observations implicate a warming climate). What is the main (and secondary) cause of sea level rise? Attributing Climate Change – model results: Do the model results implicate anthropogenic causes for climate change – how so or how not so? What does the future hold, what sort of T increases are predicted over the next 100 years? Putting this all together – what are the key pieces of evidence that human activities have, or have not cause climate change? I.E. CAN YOU STATE A CONCISE 3-POINT "CASE" IN FAVOR OF ANTHROPOGENIC GLOBAL WARMING?

Water Chemistry:

• General Features: Identifying, describing the key processes in the water cycle. What is the difference between ground and surface water (chemically and non-chemically)? Calculating solubility of gases and solids. What are the (other) main types of chemical processes that we considered for water chemistry?

• Redox Chemistry: What is the primary oxidant in natural waters? What are its two main sources? What is its main sink? The pE sale – what do the values mean? Aerobic vs. Anaerobic conditions – what is the difference in terms of pE value, dissolved O_2 levels, chemical composition (oxidized vs. reduced species), etc.? What factors lead to aerobic or anaerobic conditions? What is the effect of a large load of organic latter on a river, stream. lake etc.? What is the orange/brown precipitate that is often observed near springs? How is it formed?

• Acid-Base Chemistry: Carbonate Solubility – why is it enhanced by the basicity of CO_3^{-2}, and dissolved CO_2? Why is CO_2 solubility enhanced by CO_3^{-2} (Interplay between CO_2 and CO_3^{-2}). Equilibrium calcs. - both K values and concentrations. Why are waters with sulfate bearing sediments more sensitive to acid input that those with carbonate sediments? Why does acid input leach Al^{+3} and why does this lead to fish toxicity? What are the ecological consequences of ocean acidification?

Toxic Organics: What chemical factors lead to the persistence of organ-chlorine compounds? Preferential solubility: what does a partition coefficient (K_{OW}) mean? Why/ how does this quantity relate to bioaccumulation? Why/How do organo-chlorine compounds accumulate as one proceeds up the food chain?

Toxic Metals: What are the sources of the four key metals we discussed? How does acid input make them (at least metal ores) more soluble? What is (di)methyl mercury, and why is it bad?