GC 170A1 INTRO TO GLOBAL CHANGE MIDTERM STUDY GUIDE Fall 2014

FORMAT OF THE EXAM:

The **exam is worth 200 points** and will consist of questions in a variety of formats: **multiple choice questions** (about 25 five point questions), **fill-in-the-blank**, **figure or graph interpretation**, **make-a-sketch**, **short answer**, and **essay** (worth about 75 points)**.**

For the multiple-choice part of the test you will answer on the **IF/AT form** which allows partial credit:

It will be graded as follows:

Each multiple-point question on the IF-AT form will be worth either **5 points each**.

If you uncover the star that indicates the correct answer on the **first scratch-off attempt** (as in Question #1 on the example at left) you will receive **full credit (5 pts)**

If you need to scratch off **two boxes** to uncover the star, you will receive **3 points** (as in Question #2).

If you need to scratch off **three boxes** to find the star, you will receive **1 point.**

If you end up having to scratch off **all 4 boxes** to uncover the star, you will receive **0 points** for that question.

- ❑ To answer the other questions on the exam, you will **sketch or write on the test itself.**
- ❑ You may bring a **calculator** to the exam to assist you with any simple computations that may be on the test (computations will be minimal, if any.)
- ❑ No other electronic devices (smartphones, tablets, cell phones, or laptops, etc.) may be used during the exam unless you have obtained permission in advance from Dr H.

WHAT YOU ARE RESPONSIBLE FOR:

- **CLASS NOTES PACKET: TOPICS #1 through #8**
- Information presented in all class **LECTURE PRESENTATIONS** *[see the Class Follow-Up to review them]*
- The content of the **ASSIGNMENTS** you've had so far **(G-1 on Absorption Curves & G-2 on Energy Efficiency.)**
- The content of your **Self Checks** & **Readiness Quizzes (Practice Self Test on Global Change Overview, RQ-1, RQ -2, RQ-3, and RQ-4)**
- **Tests #1 and Test #2**

The best ways to focus your study:

· Focus on the key things listed on the **"TOP TEN THINGS TO STUDY"** for **In-Class Tests #1 & 2** (The TOP TEN lists are a succinct summary of most of the key concepts from the course that you should know and understand. If you haven't done so already, print out the Top Ten's and go through each one to structure your studying.)

· Do a quick review of all the **CLASS FOLLOW-UP PAGES thus far** to be sure you haven't missed any key topics or assignments

SOME GENERAL POINTERS ON HOW TO STUDY:

(1) FIGURES and **GRAPHS** in Class Notes, on your assignments and in your textbooks are usually important "synthesizers" of information ("a picture is worth a thousand words"). See the following pointers . . . . .

- You should be able to understand, interpret, and explain the figures in your reading material and class notes packet.
- In addition to word questions, you will be given some **FIGURES** or **GRAPHS** to interpret on the exam. (These will be taken directly from your textbooks or class notes packet, or will be very similar to graphs and figures you've seen in class.)
- You may receive a figure with some of the information on it "whited out" or without any labels and asked to fill in some missing information.
- *Examples of questions that might involve a figure or a graph:*
- Could you sketch in what happens to an electron when a photon is emitted (e.g. leaps to a higher or lower energy level)? *[Hint: see pp 23-24 in CLASS NOTES]*
- Could you answer questions about a figure of the electromagnetic spectrum or label the areas of x-rays, UV, visible, and IR, and microwave radiation if they were "whited out" in Fig 3-3 p. 38 in SGC-E-text?
- Could you sketch in a theoretical ABSORPTION CURVE (see p 30 in Class Notes and the G-1 activity) (for the answer, see Topic # 5 wrap on Sep 23 in CLASS FOLLOW UP)

(2) Reviewing the **Self Checks** and the **"Top Ten"** things to study listed for Test #1 & # 2 is a good place to begin your studying to be sure you recall what you read in the textbook. The exam questions, however, will be more demanding than the Readiness Quiz-type questions. In particular, they will ***emphasize the application and synthesis of the knowledge*** you've gained since the beginning of the semester, not just the memorization of facts, ideas, and concepts.

(3) An important part of your studying should be to **TIE TOGETHER** different topics that we've covered and to make connections between how the same topic is addressed in Class Notes, lecture notes, and the SGC E-text. **This is also the point in the semester when you should be able to start tying the concepts together into "a big picture."** Questions will be asked that require you to link up different parts of the course. As you read over the material and study it, be constantly asking yourself questions (and answering them) to test your own understanding.

- *Examples of questions that tie concepts from different parts of the semester together:*

  How does knowing that ozone in the stratosphere absorbs incoming shortwave radiation help you explain why the atmospheric temperature heats up in the stratosphere?
- On an absorption curve of the whole atmosphere (see bottom of p 32 in Class Notes and Topic #5 Part II) where are the two "atmospheric windows" mentioned in class (i.e., wavelength ranges where radiation moves through the atmosphere relatively unimpeded)? Why are they called windows? What is the difference between the UV/Visible "atmospheric window" and the "outgoing IR" atmospheric window?

(4) The EXAM will NOT cover the following reading: Pages 9-17 in SGC-E-Text Chapter 1.

THE MAIN TOPICS THE EXAM WILL COVER

Topic # 1 Global Change Science and Issues, On Being a Scientist

-- Go over the notes on this in Class Notes and review the key themes about science, hypotheses, theories, laws etc, that we went over in class

Topic #2 Quantifying Global Change

--Be familiar with the Powers of Ten and scientific notation (pp 12 in Class Notes); Know how to describe different types of time series plots (pp 13-14 in Class Notes).

Topic # 3 Energy & Matter Overview

· Can you describe what **matter** is and what it is made up of?

· Can you explain the basis for how elements are arranged in the **Periodic Table**? Could you arrange an element in its proper row or column if you were given a way to figure out the number of protons in the element and the number of electrons in its outermost shell?*(We did this in class -- and you can review it again on your own in the Periodic Table Background activity in Class Notes pp 109-113.*

· Can you describe or sketch the unique way that **electrons** behave and how **photons** of electromagnetic energy are emitted or absorbed when electrons make **quantum leaps** between energy levels in their orbit around an atomic nucleus? (Remember, electrons are *matter* and they do the quantum "leaping" while photons are *energy* which is emitted or absorbed – see pp 23-24 in Class Notes)

· Can you describe the **quantum behavior of molecules** (not atoms) when certain molecules rotate and vibrate at specific frequencies and why this explains why some gases are greenhouse gases and some are not? (Remember, atoms, & molecules are *matter* and they do the quantum rotating/vibrating, while photons are *energy* which is emitted or absorbed – see pp 48-50 in SGC-E-text

Topic #4 Electromagnetic Radiation & the Electromagnetic Spectrum

· Can you explain how **electromagnetic energy** behaves (wave & photons, wavelength & frequency)?

· Do you understand the **electromagnetic spectrum**, know its order, and the **wavelength ranges of UV, visible, and IR radiation**? By "order" I mean the relative wavelength from short to long: of gamma, x-rays, UV, visible, IR, microwaves & radio waves? Which wavelengths tend to be harmful to life on Earth?

· Do you know what the **typical sources** of the different wavelengths of electromagnetic radiation are? *(see p 26 in Class Notes and the additional reading on* The Electromagnetic Spectrum) **UV, visible light and IR radiation**, can you link this back to the discussion of matter (Topic #3) and the **quantum** behavior of electrons and molecules -- i.e. Do you know **which wavelengths of the Electromagnetic Spectrum** involve quantum leaps in atoms and which involve vibrational and rotational behavior in molecules?

Can you tie what you know about electromagnetic radiation and the radiation laws (see next topic) to the **SAVED BY THE SUN**video?

Topic # 5 The Radiation Laws

· Do you **understand the radiation laws** (e.g. Wien's Law, Stefan-Boltzmann Law, inverse-square law, concept of a blackbody and why these concepts are keys to understanding many global change concepts?

· Do you know the **peak wavelengths** of transmission of **solar energy (0. 5 µm)** and **terrestrial energy (10. 0 µm**)? [memorize this – note how it looks in a figure as well (Fig 3-8 on p 42 of SGC-E-text)

· Do you understand what **absorption curves** are (including how to read them and draw a simple, hypothetical one as on p 30 in Class Notes and in G-1)? Do you understand what they reveal about the greenhouse effect, atmospheric transmissivity and absorption by different gases, and the interaction of atmospheric gases with solar (shortwave) and terrestrial (longwave, IR) radiation? **ç a TIE-TOGETHER concept!**

· Can you succinctly explain **what greenhouse gases are** and what **the natural greenhouse effect** is? Here's are some definitions – be sure you understand these and be able to re-state these in your OWN words:

Greenhouse gases (GHG's) (def): Gases such as carbon dioxide, methane, nitrous oxide, and water vapor that warm a planet's surface by absorbing infrared radiation and reradiating some of it back toward the surface.

IMPORTANT: reradiating is NOT "reflecting" or "bouncing" !! Terrestrial infrared radiation (IR) is absorbed by the GHG's, then emitted (radiated back out) by the GHG's. The IR does not "bounce off" or "reflect off" the GHG's or the atmosphere!

Greenhouse effect (GHE) (def): The natural mechanism by which a planet's surface is warmed by infrared – absorbing gases in its atmosphere. (NOTE: we use the term "**anthropogenically enhanced greenhouse effect"** to describe the increase of the GHE due to the accumulation of additional GHG's contributed by human activities such as the burning of fossil fuels).

Can you explain the processes associated with the **natural greenhouse effect** in words or a cartoon diagram? [Go through the **Class Concepts Self Test** on p 33 of Class Notes to be sure you understand these concepts.] **NOTE: only these two arrows (representing IR) are involved in the GHE è**

REMEMBER: the **GHE involves longwave (LW) infrared (IR) radiation ONLY** – the parts of the cartoon diagram showing shortwave (SW) solar radiation are NOT part of the GHE and should not be used in an explanation of the GHE!!

Topic # 6 Atmospheric Structure & Composition

· Can you explain how the atmosphere's **structure and temperature** varies with altitude, and what causes these variations?. (See Fig. 3-9 and 3-11 in SGC-E-text and pp 35-36 in Class Notes.)

· Can you reason out and answer the Q's about the **Transfer & Absorption of Solar Radiation figure** on the bottom of p 36 of Class Notes?

· Do you know what **gases are the most abundant** in the atmosphere and which gases are considered **GREENHOUSE GASES** (Table 3-2 in SGC-E-text & p 37-38 in Class Notes). Do you understand that nearly all of the major GH gases come from *both* natural and anthropogenic sources, but that their concentration began to increase rapidly in the 20th century, primarily due to the anthropogenic sources (be familiar with some of the these sources). Know which type of GH gases are human-made only.

· Can you describe and explain the "Greenhouse Signature" (see p 37in Class Notes) and why cooling in the stratosphere would take place with a stronger greenhouse effect warming in the troposphere?

· Review the **KEY CONCEPTS** on p 39 in Class Notes -- it's a good summary of some important points!

Topic #7 Laws of Thermodynamics & Motion

· Do you understand the differences between the similar-sounding concepts of **Thermal Energy, Temperature, and Heat?**

· Do you understand what **specific heat** is and how to interpret the table on p 41 in Class Notes?

· Can you describe the differences between the **energy transfer** processes of: **conduction**, **convection**, and **radiation**?

· If the **1st & 2nd Laws of Thermodynamics** were stated for you, could you match them with a real-world application (e.g. direction of heat energy flow from hotter to colder body) *(You don't have to memorize the Laws, just be know what they mean if they are stated for you.)* For a chellenging SELF CHECK on this see Q1-Q3 in the middle of p 44 in CLASS NOTES. Could you explain how car exhaust is a manifestation of the 2nd Law of Thermodynamics and hence also related the the concept of "entropy"? (see Topic #7 Part II in Class Follow UP and p 43 in Class Notes).

· Do you know how to read and interpret an **energy flow diagram** like those you drew for the light bulbs in class? Can you depict the energy flow in a diagram for a very inefficient light bulb vs a very efficient light bulb. Could you sketch and label your own energy flow diagrams for different types of like you did in the G-2 exercise?

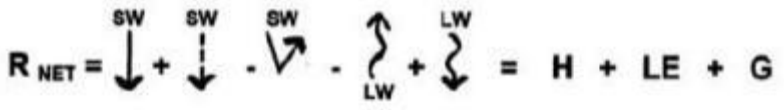
· Do you understand how the **Law of Inertia** (Newton's 1st Law) and a body's **mass** (as in Newton's 2nd Law) determine the amount of**force** (and the energy needed to apply the force) to get a big, heavy vehicle **accelerating** from a stop vs. a small, light vehicle? Do you understand how the Law of Inertia is related to ENERGY EFFICEINCY in transportation (e.g., freight trains vs trucks, small automobiles vs. large, etc.)

· Could you calculate the **energy efficiency** of a power plant, automobile or other heat engine as we did in class for the coal power plant and you did for the automobile in G-2 (see p 116 in Class Notes).

· Could you explain the **difference between Land and Ocean n the rate of global warming** that is seen in the 2 graphs in the middle of p 41 in Class Notes? Can you answer the two Q's on the bottom of p 41?

Topic #8 The Global Energy Balance

- Do you know and understand the symbols of the **Energy Balance Equation** and the difference between what the left-hand and right-had sides of the equation represent? Could you **put the + and - signs** in the right place in the equation? Could you write out the equation yourself using the symbols? (NOTE: The right-hand side (H + LE + G) will be explained in Tuesday's class)



- Do you know **which symbol** (or symbols) refer to the **Greenhouse Effect ?** Which symbol represents incoming solar radiation on a cloudy day? Which symbol represents the way the **Earth 'cools itself'** by sending out to space through the **IR atmospheric window?**

- Do you understand the concept of **albedo**? What kinds of surfaces on Earth have high albedos and what have low albedos? How would the distribution of energy in the different components of the Energy Balance represented by the symbols change if ALL of the arctic sea ice melted? Which symbols would be affected?

- Do you have a feel for **how much energy** is in each of these components of the Global Energy Balance? (HINT: see t**he width of the arrows** in the diagram on p 49 in CLASS NOTES. Could you **label the pathways in this figure** with the symbol they represent (like we did in class on Oct 9th)?

- Do you understand the difference between **Sensible Heat (H) and Latent Heat /(Energy (LE)** ? *(Class Notes p 52 -- to be covered in class on Tuesday)*

- Do you understand which segments of the **phase change graph of H2O** (from solid => liquid => gas) represent Sensible Heat and which represent Latent Energy ? *(Class Notes p 52 -- to be covered in class on Tuesday)*

Synthesis and Tying Topics Together

- Can you now see how items in the individual topics we've been covering are related to each other? Can you fit the "pieces of the puzzle" together into a connected understanding? *Some examples:*
  - How does atmospheric composition (Topic #6) relate to the Radiation Laws & the Greenhouse Effect? (Topic #5)
  - How do photons(Topic #4 relate to the energy transfer process of radiation? (Topic #7)?
  - How does the nature of matter and energy (Topic #3) relate to the energy transfer process of conduction (Topic #7)
  - How do the Energy Balance Equation symbols (Topic #8) represent some of the processes in the previous topics?

Click here for: **PRACTICE QUESTIONS**