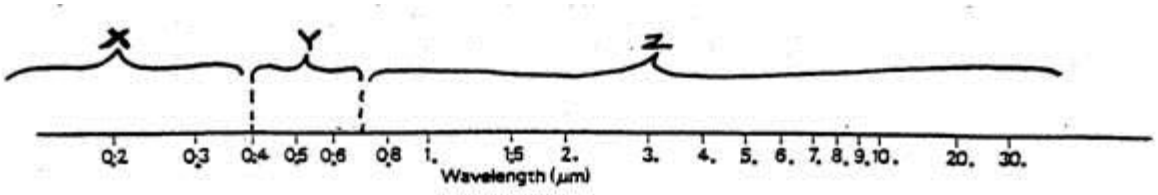
GC 170A1 Midterm Practice Questions- Fall 2014

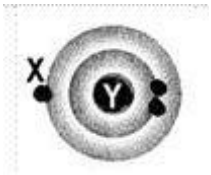
Here is an assortment of practice questions selected from previous exams that are good examples of the types of questions that will be on this year's Midterm Exam. I can't give you practice on *every* kind of question I will ask, and on *every* topic I will ask about, but these practice questions should help you get an idea of what the exam will be like and will help you review some key concepts. *NOTE: For additional practice, review the questions in the Self Checks & RQ's, and Test #1 and #2 NOTE: The exam itself will not be as long as this set of practice questions. It will contain about 25 multiple choice questions (5 pts each, with the rest of the questions being, fill-in-the-blank, make-a-sketch, and a short answer-essay question.*

Question #1 (a, b, & c) refers to the figure below which represents a portion of the **Electromagnetic Spectrum** with wavelengths shown (in micrometers, μm) along a horizontal line and sections of the spectrum bracketed and labeled.



(a) Which bracketed section of the spectrum represents visible light? *(Circle one)* X Y Z
(b) Which bracketed section of the spectrum represents infrared wavelengths? *(Circle one)* X Y Z
(c) Which bracketed section of the spectrum represents ultraviolet wavelengths? *(Circle one)* X Y Z

2. In the dot diagram of the atom shown at right, Feature X represents one of the atom's **electrons** & Feature Y represents the atom's **nucleus**. If this atom has a neutral charge, how many positively charged **protons** does the nucleus contain:



a) one **b) two** **c) three** **d) four**

3. If a **photon** of electromagnetic energy (with just the right frequency and wavelength) is **absorbed** by the electron represented by Feature X in #2 , which of the following is likely to happen:

a) energy will be absorbed by the photon
b) energy will be emitted by the electron
c) the photon will make a quantum leap to a lower energy level
d) the electron will make a quantum leap to a higher energy level

4. The Earth is heated by incoming radiation from the sun, with the greatest intensity occurring in the visible (light) part of the electromagnetic spectrum, and then the Earth cools by radiating infrared (IR) back out to space through the ozone hole. (a) True (b) False

5. If it weren't for the Greenhouse Effect, the Earth's average surface temperature would be well below the freezing point of water. (a) True (b) False

6. The Earth's temperature depends on three main factors. Which of the following correctly lists these factors:

a) the Earth's reflectivity, Solar radiation (flux), and clouds
b) the Earth's reflectivity, the amount of ice cover on the planet, and the amount of forest cover
c) the Solar flux, the Greenhouse Effect, and the ozone layer
d) the Solar flux, the Greenhouse Effect, and the Earth's reflectivity

7. We use wave terminology to describe the behavior of electromagnetic radiation. The relationship between **wavelength (λ), wave frequency (ν)** and **wave speed (c, the speed of light)** can be depicted in equation form as: **$c = \lambda \nu$** If the wave speed (**c**) is constant, which of the following best describes the relationship between wavelength and frequency:

a) "the longer the wavelength, the lower its frequency"
b) "the longer the wavelength, the higher its frequency"
c) "the shorter the wavelength, the lower its frequency"
d) "the shorter the wavelength, the lower its speed"

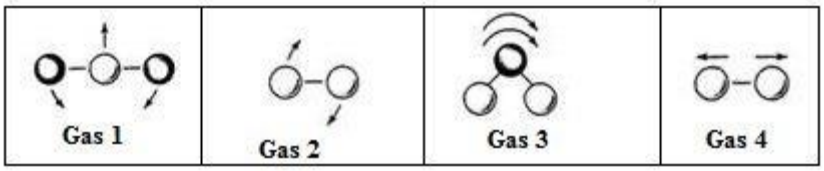
8. The atmospheric layers of the **troposphere** and the **stratosphere** are important to global climate change because:

a) they are the two layers <u>closest to the sun</u>, which is the source of the Earth's energy
b) they are the two layers in which <u>temperature INCREASES with altitude</u> in the atmosphere
c) they are the layers in which most of our <u>weather and heat transfer</u> occur (i.e., in the troposphere) and where most of the atmosphere's <u>ozone</u> occurs (i.e., in the stratosphere)
d) they are the layers having the lowest atmospheric pressure.

9. According to the prevailing theories described in your SGC-E Text text, the ability of various greenhouse gases to absorb and emit photons of infrared radiation depends on:

a) the frequency at which they are rotating compared to the wavelength of radiation
b) the amplitude at which they are vibrating compared to the wavelength of radiation
c) the number of protons present in the molecule
d) BOTH a and b can influence which wavelengths of infrared radiation are absorbed or emitted.

10. Select the statement below that best states **the reason why** some of the gases depicted below are more likely to be **greenhouse gases** than the other gases shown -- according to the **theory of quantum mechanics**?



a) Gas 2 and Gas 4 are more likely to be greenhouse gases because the rotation, vibration, and bending behavior of their **symmetric diatomic structure** can occur at discrete frequencies that allow the **absorption and emission of IR** (infrared) electromagnetic wavelengths

b) Gas 2 and Gas 3 are more likely to be greenhouse gases because they **rotate and don't bend** and <u>*rotation*</u> at discrete frequencies is associated with the **absorption and emission of IR** (infrared) electromagnetic wavelengths

c) Gas 1 and Gas 3 are more likely to be greenhouse gases because the rotation, vibration, and bending behavior of their **asymmetric triatomic structure** can occur at discrete frequencies that allow the **absorption and emission of IR** (infrared) electromagnetic wavelengths

d) None of these figures illustrates a greenhouse gas, because the figures show molecules *only* and the absorption and emission of IR (infrared) electromagnetic wavelengths occurs ***within atoms*** (not molecules) when electrons absorb and emit IR **photons** of radiation.

11. Which of the following is **one of the five most abundant gases** in the Earth's atmosphere **AND** is also a **greenhouse** gas?

a) Argon (Ar) b) Carbon dioxide (CO_2) c) Ozone (O_3) d) Nitrogen (N_2)

12. Which of the following is a CORRECT statement about the difference between **ultraviolet (UV)** electromagnetic radiation and **infrared (IR)**electromagnetic radiation?

a) UV electromagnetic radiation has a **shorter wavelength** *and* **lower frequency** than IR electromagnetic radiation
b) UV electromagnetic radiation has a **higher energy** *and* **higher frequency** than IR electromagnetic radiation
c) UV electromagnetic radiation plays **a more primary role in the greenhouse effect** than IR radiation
d) UV electromagnetic radiation is **closer** in the electromagnetic spectrum to **microwave, radar, and radio** frequencies than is IR radiation

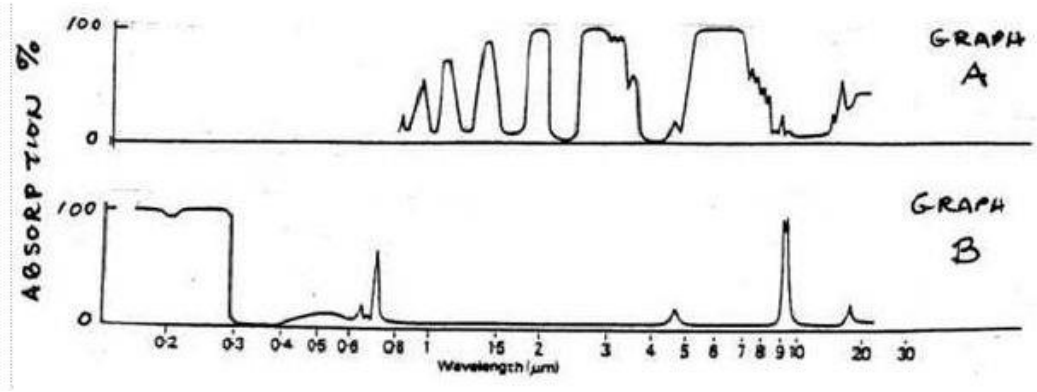
13. One of the Radiation Laws -- called Wein's Law -- is a statement about the relationship between the ***temperature*** of a substance and the ***wavelength*** at which radiation from that substance is emitted. Which of the phrases below CORRECTLY states the "rule" for Wein's Law?

a) The **wavelength of radiation** a body gives off is proportional to the fourth power of its absolute **temperature**.
b) **Shorter** wavelengths involve **higher intensity** radiation fluxes than **longer** wavelengths
c) The **hotter the temperature** of the body, the **longer the wavelength** maximum emission of radiation from that body.
d) The **hotter the temperature** of the body, the **shorter the wavelength** of maximum emission of radiation from that body.

14. Now circle the letter of the symbolic notation (formula) that best represents what Wein's Law is saying (**refer to #13**). *Key to notation:* [E = radiation emitted, T = temperature, λ = wavelength, a = a constant]

a) $\lambda = aT^2$ b) $E = a T^4$ c) $\lambda = a/T$ d) $E = \lambda / a$

QUESTIONS #15 through # 17 refer to the figure below:



15. Which one of these phrases based on the Radiation Laws best explains why absorption bands exist?

a) The amount of radiation passing through a unit area is inversely proportional to the square of the distance of that area from the source
b) All substances emit wavelengths of radiation as long as their temperature is above absolute zero.
c) As substances get hotter the wavelength at which radiation is emitted will become shorter.
d) Some substances emit and absorb radiation at certain wavelengths only.

16. **GRAPH A** depicts absorption by a gas that absorbs electromagnetic energy that is mostly:

a) in the visible light part of the spectrum
b) ultraviolet radiation
c) infrared radiation
d) microwave radiation

17. **GRAPH B** depicts absorption by a gas that absorbs electromagnetic radiation that is:

a) mostly longwave radiation b) mostly infrared radiation c) both solar and terrestrial radiation

18. Which of the following best states the **differences between solar (Sun) and terrestrial (Earth) radiation** in terms of the **electromagnetic spectrum**:

a) The Earth emits most of its radiant energy as short-wave radiation (< 1 micrometer) while the sun's radiation peak is in the long-wave (>1 micrometer) portion of the spectrum.
b) The Earth's radiation peak is in the ultraviolet portion of the spectrum while the sun's radiation peak is in the visible light portion of the spectrum.
c) The Sun's wavelength of peak emission is about 0.5 micrometer while the Earth's wavelength of peak emission is about twenty times longer at about 10 micrometers.
d) Solar radiation involves the greenhouse effect, which operates mostly in the visible part of the spectrum, while terrestrial radiation does not involve the greenhouse effect.
e) The Sun radiates *only* in the visible light part of the spectrum while the Earth radiates *only* in the infrared part of the spectrum.

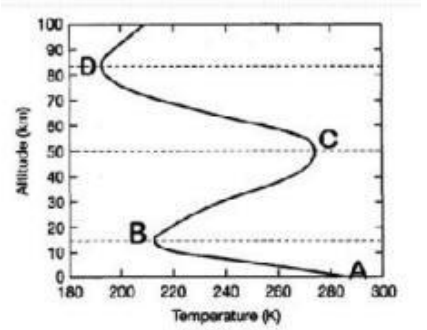
For **QUESTIONS #19 through #21**: Fill in the blank with letter **a, b, c,** or **d** to match each of the following statements about forms of **energy transfer** with the proper process, depending on which type of energy transfer best represents the statement. **a) Convection** **b) Conduction** **c) Electromagnetic Radiation**

19. ____ energy transfer by means of **vibrational energy from one molecule to the next** through a substance.
20. ____ the predominant form in which **energy involved in the Greenhouse Effect** is transferred
21. ____ energy transfer by means of **large-scale movements of material** within a fluid

22. **Ultraviolet (UV) radiation** can be classified by wavelength range into three types of radiation: UVA with a wavelength range of 320-400 nanometers (nm), which is equivalent to .32 -.40 micrometers (µm), UVB with a range of 290-320 nm or .29-.32 µm, and UVC with a range of 200-290 nm or .20 - .29 µm. **Which of the following statements about these UV ranges is correct:**

a) UVC radiation is relatively harmless to life while UVA radiation is extremely harmful
b) UVC is the most harmful wavelength range because its wavelengths are the shortest and therefore the highest energy wavelengths
c) UVA is the same UV radiation range that is almost completely absorbed by ozone in the stratosphere.
d) On the electromagnetic spectrum, UVC radiation is closer to visible light than UVB radiation

Questions 23 –26 Referring to the diagram at left, give the names of the following layers of the atmosphere:



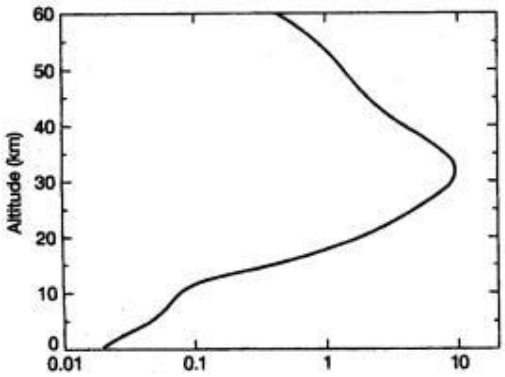
23. The layer from A to B is named: _____

24. The layer from B to C is named: _____

25. The layer from C to D is named: _____

26. The layer above D is named: _____

27. At RIGHT is a figure showing a **"mystery something" which is varying with altitude** in the Earth's atmosphere, but the label on the horizontal axis is missing! Select the choice below which is **the most likely label** for the horizontal axis of the figure:



[HINT: figure out the altitude of the TROPOPAUSE from the figure for Questions # 23-26.]

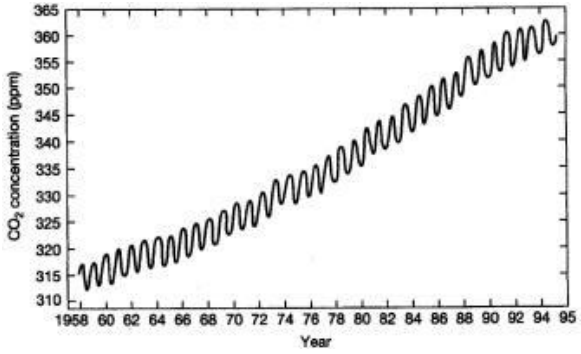
a) The figure is showing how *atmospheric pressure* varies with altitude, with the greatest pressure at ~ 30 km. Therefore the label for the horizontal axis should be **Air Pressure.**

b) The figure is showing how the concentration of one of the primary *greenhouse gases* varies with altitude, with a primary peak at ~ 30 km in the **troposphere.** Therefore the label for the horizontal axis should be **CO_2 Concentration.**

c) The figure is showing how the concentration of *ozone* (O_3) varies with altitude, with the greatest concentration in the **stratosphere.** Therefore the label for the horizontal axis should be **Ozone Density.**

d) The figure is showing how *temperature* varies with altitude, with warm temperatures at the Earth's surface, even warmer temperatures in the mid-troposphere ,, and the coolest temperatures near the top of the troposphere. Therefore the label for the horizontal axis should be**Air Temperature.**

28. Which of the following best describes the kind of global change revealed by the **Keeling Curve** show at right:



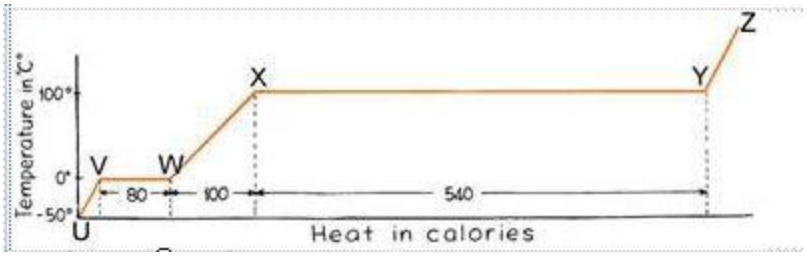
a) The Keeling Curve indicates that carbon dioxide concentration in the atmosphere has experienced an **increase in variance si**nce 1958, in addition to annual **quasi-periodic oscillations** of CO_2 that occur due to seasonal variations in global photosynthesis and respiration.

b) The Keeling Curve indicates that carbon dioxide concentration in the atmosphere has experienced an **increasing trend** since 1958, in addition to annual **quasi-periodic oscillations** of CO_2 that occur due to seasonal variations in global photosynthesis and respiration.

c) The Keeling Curve indicates that carbon dioxide concentration in the atmosphere has experienced a **constant mean** over time since 1958, except for the annual **quasi-periodic oscillations** that occur due to seasonal variations in global photosynthesis and respiration.

d) The Keeling Curve indicates that carbon dioxide concentration in the atmosphere has experienced **can abrupt step change** and an**increasing variance** (range of fluctuations) since 1958, due to seasonal variations in global photosynthesis and respiration.

29. The graph at right shows **how the temperature of one gram of H_2O changes as calories of heat energy are added to the H_2O**.



Using the graph to help you, **select the one statement** below that best describes the relationship between the concepts of **Latent Heat (LE),Sensible Heat (H),** and **phase changes (changes of state)** in H_2O:

a) **Segment W-X** of the graph indicates that 100 calories of energy are being added to one gram of H_2O **without changing the temperature** of the H_2O at all. This energy is called **Latent Heat (LE)**.

b) **A comparison of Segment V-W** with **Segment X-Y** of the graph indicates that it takes **much more energy** (in calories of LE) to create a **phase change from liquid to vapor** than it does to create a **phase change from ice to liquid.**

c) **Segments U-V, W-X, and Y-Z** of the graph indicate that, even though calories of energy are added to one gram of H_2O, **the H_2O does not change its temperature** and heat up. This is because the energy being added in **represents LE** and is being used to **change the state** of the H_2O from solid to liquid, or liquid to vapor.

d) **Segments V-W and X-Y** of the graph represent **sensible heat (H),** while **Segment W-X** of the graph represents **latent heat (LE).** Only **Segment W-X** represents a **phase change**.

30. Energy transfer by means of **large-scale movements of material** within a fluid (liquid or air) occurs in **which one** of the following processes:

a) convection b) conduction c) latent energy d) terrestrial infrared radiation e) shortwave solar radiation

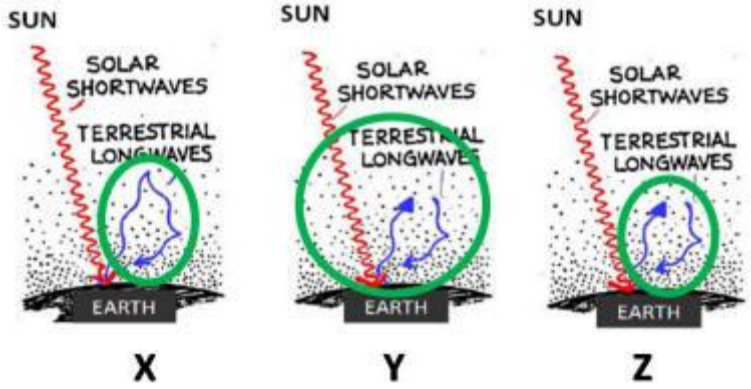
31. Energy transfer by **waves or pulses of energy** that involve **photons** occurs in **which one** of the following processes:

a) sensible heat b) convection c) conduction d) shortwave solar radiation

32. **Specific heat** is the amount of energy (in calories) that is needed to raise one gram of a substance one degree Celsius. The specific heat of **water = 1.0 calorie** and the specific heat of **sand = 0.20 calorie**. If we add the *exact same amount* of energy to one gram of **water** having a temperature of 15ºC and one gram of **sand** having a temperature of 15 ºC, which of the following is most likely to be true?

a) the sand and water will **both heat up** to the same temperature in the **same amount of time**
b) the **sand will heat up faster** and reach a warmer temperature than the water
c) the **water will heat up faster** and reach a warmer temperature than the sand
d) all of the energy going into the water will go into the **latent energy** form, hence the **water won't heat up at all**

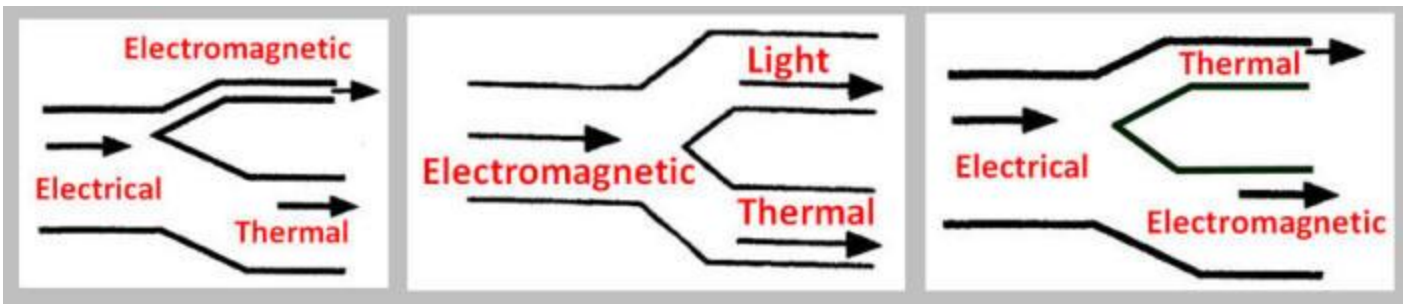
33. In the figures below, which circled area is the best depiction of the **GREENHOUSE EFFECT?** *[HINT: The best depiction will be a circled area that includes the correct type of radiation (shortwave or longwave) and illustrates absorption and re-radiation of that radiation]*



a) the area circled in **Figure X** b) area circled in **Figure Y** c) area circled in **Figure Z**

d) none of the figures show the **GREENHOUSE EFFECT** exactly as we have seen it and discussed it in class

34. Which **energy flow diagram** below is best depicts the diagram of a **well-designed, highly energy efficient LED light bulb?**

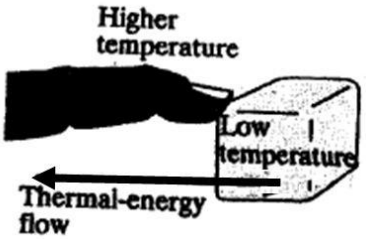


(a) (b) (c)

35. The diagram at left shows the relative amounts of **potential energy (PE)** and **kinetic energy (KE)** that are involved in a diver's plunge to the ground. In the diagram**, the fact that KE + PE = 1000 at each point in time (even though the values of KE and PE change)** represents *which one* of the following LAWS of physics:

a) 1st Law of Thermodynamics: "In an isolated system the total amount of energy is conserved, although energy may change from one form to another."
b) The Inverse Square Law
c) The Law of Gravity
d) 2nd Law of Thermodynamics: "Every isolated system becomes disordered with time."

36. Select the statement that properly describes the figure at right:



a) The figure is a good depiction of the **1st Law of Thermodynamics** = "In an isolated system the total amount of energy is conserved, although energy may change from one form to another over and over again."

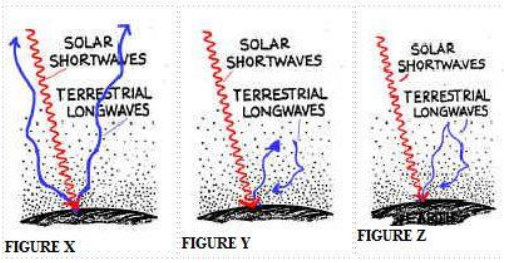
b) The figure is a good depiction of the **2nd Law of Thermodynamics** = "Energy flows from a higher-temperature object to a lower-temperature object. It will not spontaneously flow the other way."

c) The figure is a an incorrect depiction of the **1st Law of Thermodynamics** because there is no change of energy going on in the figure

d) The figure is an incorrect depiction of the **2nd Law of Thermodynamics** because the thermal energy flow is going in the wrong direction.

SAMPLE ESSAY QUESTION (and a few more multiple choice too!)

37. In class we discussed these three "cartoon" figures and selected one that is **a more accurate** depiction of the processes involved in the **natural greenhouse effect.**



(a) Which figure above is the more accurate depiction of the natural greenhouse effect? **Figure ____**

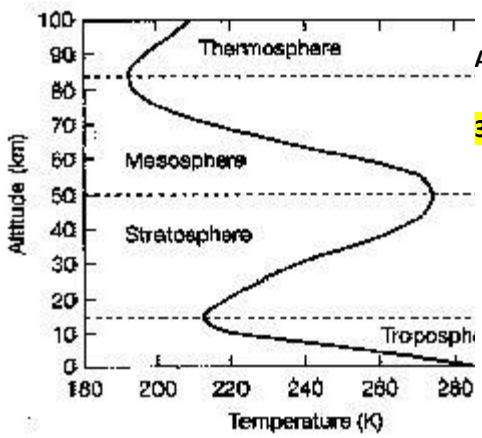
(b) On the figure you selected, **CIRCLE** the part of the diagram which represents the energy processes DIRECTLY involved in the **greenhouse effect.**

(c) **Explain <u>WHY</u>** the figure you selected is a <u>more</u> accurate depiction of the natural Greenhouse Effect <u>than the other two figures.</u>

(d) Finally, give a precise and scientifically accurate **DEFINITION** of the **natural Greenhouse Effect** in your <u>own</u> words.

[NOTE: By "natural greenhouse effect" I mean the naturally occurring greenhouse effect, not the "enhanced greenhouse effect" that arises from anthropogenic activities such as humans increasing the concentration of greenhouse gases by burning fossil fuels].

38. In the diagram below, the layer of the atmosphere where the **Greenhouse Effect** has its greatest influence is the:
a) troposphere b) stratosphere c) mesosphere d) thermosphere



ANOTHER SAMPLE ESSAY QUESTION:

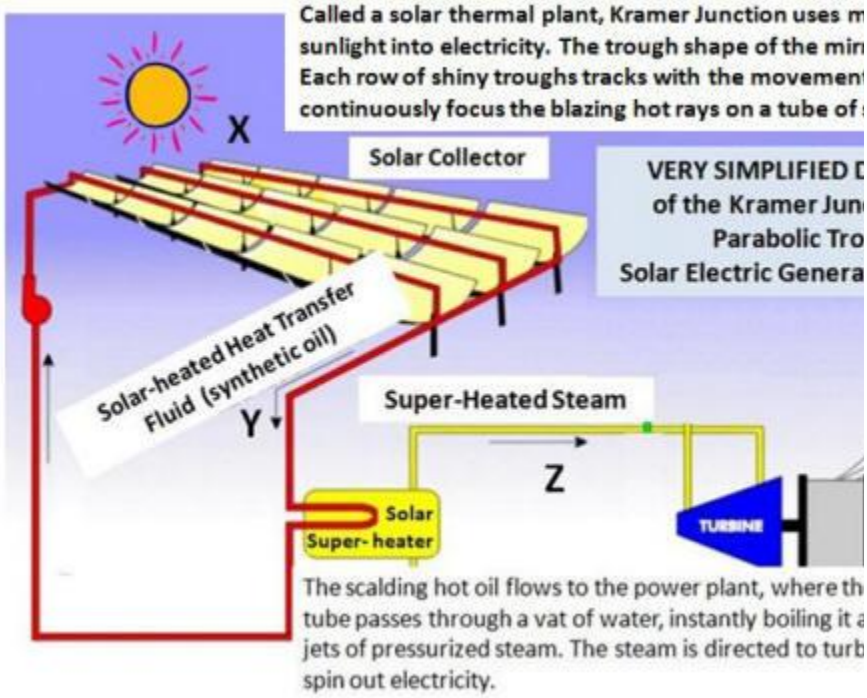
39. Briefly explain what causes the change in temperature with height in each of the following layers:

a) the <u>troposphere</u> decreases in temperature with height because:

b) the <u>stratosphere</u> increases in temperature with height because:

40. FILL IN THE BLANKS with one of the following terms to complete each sentence properly.

conduction
convection
radiation
sensible heat
latent heat



The diagram at right is a greatly simplified version of how the large southern California solar power plant at Kramer Junction (in the *Saved by the Sun* video) generates electricity from solar energy.

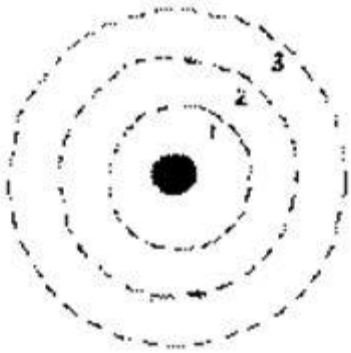
(a) ENERGY is transferred from X-to-Y (from the SUN to the SYNTHETIC OIL in the red tubes) by _____

(b) When water in the **Solar Super-heater vat** <u>boils instantly</u>, the Y-to-Z heat transfer that occurs can be described as the transfer of _____ in the SYNTHETIC OIL to _____ in the STEAM .

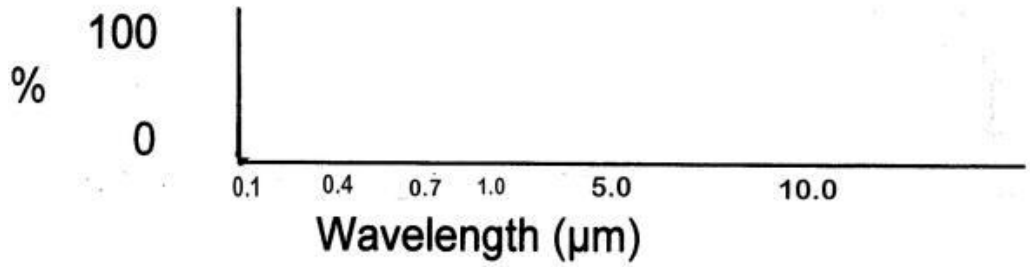
SAMPLE MAKE-A-SKETCH QUESTION:

41. On the diagram, illustrate **<u>photon behavior</u>** by **MAKING A SKETCH** which shows what happens ***when an electron in an excited state <u>drops</u> to a <u>lower</u> energy level***.

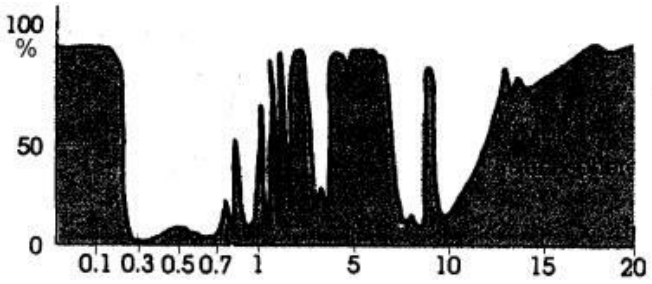
Then **LABEL** your sketch to identify the names of all the features you have drawn in.



42. On the blank graph below, sketch in a line that represents the absorptivity of a hypothetical atmosphere that has **NO** ability to absorb**visible** light OR **infrared** radiation, but CAN absorb **ALL ultraviolet** radiation



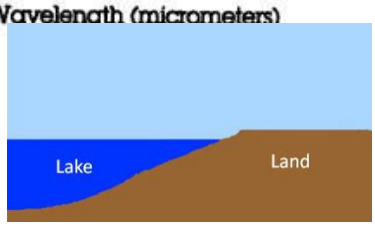
43a. DRAW A CIRCLE around the **UV+ visible light** atmospheric window region on this absorption curve for the whole atmosphere and **explain WHY this wavelength range is referred to as an "atmospheric window."**



43b. Next, **DRAW A CIRCLE** around the **IR atmospheric** window region and **explain what is happening in this window** and **why it is so important** for the Earth's Energy Balance.

44. If **exactly the same amount of solar energy** was delivered to the lake surface and the land surface on a sunny day, **what would the surface temperature be like at sunset?**

(a) the land surface would be hotter,
(b) the lake surface would be hotter,
(c) the surface temperature of the land and lake would be the same



Explain the reasons for answering as you did. Would the surface you selected above still be hotter than the other surface at dawn the next day? Why or why not?

45. Complete the RADIATION BALANCE EQUATION by filling in the proper cartoon symbols in the blanks:

R_{net} = _____ + _____ - _____ - _____ + _____ = _____ + _____ + **G**

46. Energy transfer by waves or pulses of energy that involve photons occurs in which one of the following processes:

a) **H** in water b) Specific Heat c) SW d) inertia

In your own words, explain your answer .

47. Trucks and SUVs are massive vehicles which tend to consume a lot of gas and are far less fuel efficient than smaller, less massive compact and subcompact cars, especially in stop-and-go traffic.

In your own words, explain WHY in terms of one or both of the Laws of Motion stated for you below:

Newton's 1st Law states that all bodies have inertia and that a body's mass is the measurement of the inertia. The 1st law also states that a moving object will continue moving in a straight line at a constant speed unless acted on by a force

Newton's 2nd law can be written F = ma and says that the acceleration (a) of a body is directly proportional to the net force (F) acting on the body and inversely proportional to the mass (m) of the body .