Part I – Short Answer

Choose a letter to fill in the blanks. Use choices as many times as you wish. Only one choice is needed per blank. All are 3 points each.

1.
A. ammonia
B. CFCs
C. HCFCs
D. HFCs
E. NONE of these
F. ALL of these

_F___Which can be used as a **refrigerant gas**?

_B___Which has the **longest lifetime** in the atmosphere?

_A___Which one is **highly toxic**?

_A___Which of these is **highly soluble** in water?

2.
A. 1 mole of ethanol (= ethyl alcohol)
B. 1 mole of ethane
C. 1 mole of ethene (=ethylene)
D. 1 mole of ethyne (=acetylene)
E. ALL of these are the same

_D__ has the smallest **mass**

_A__ contains the largest number of **atoms** (these atoms can be part of molecules)

_E__ contains the smallest number of **molecules**

_E__ produces the most **moles of CO_2** when burned

3.
A. Visible light
B. UV radiation
C. IR radiation
D. ALL of these
E. NONE of these

__A__ Provides the energy that green plants use for photosynthesis.

__E__ Can cause the oxygen molecule to vibrate (stretch and bend)

__B__ Can break the bond in the oxygen molecule.

__C__ Is emitted by the Earth as well as the Sun.

Part II. Gasoline (first part)

1. Hexane is a component of gasoline. The density of hexane is 0.658 g/ml.

a. (4 points) Which would weigh more, a milliliter of hexane or a milliliter of water?

hexane Explain your reasoning in 10 words or less:

water **Water is more dense than hexane.**
(or gasoline is less dense than water)

the same

b. (3 points) There are ___6079____ milliliters in 4000 grams hexane. SHOW WORK.

$$4000 \text{ g hexane} \times \frac{1 \text{ ml hexane}}{0.658 \text{ g hexane}} = 6079 \text{ ml hexane}$$

c. (7 points) If you burn 3,500 grams of hexane (roughly a gallon) in plenty of oxygen, how many grams of carbon dioxide do you get? SHOW WORK.

$$\mathbf{C_6H_{14} + 19/2\ O_2 \longrightarrow 6\ CO_2 + 7\ H_2O}$$

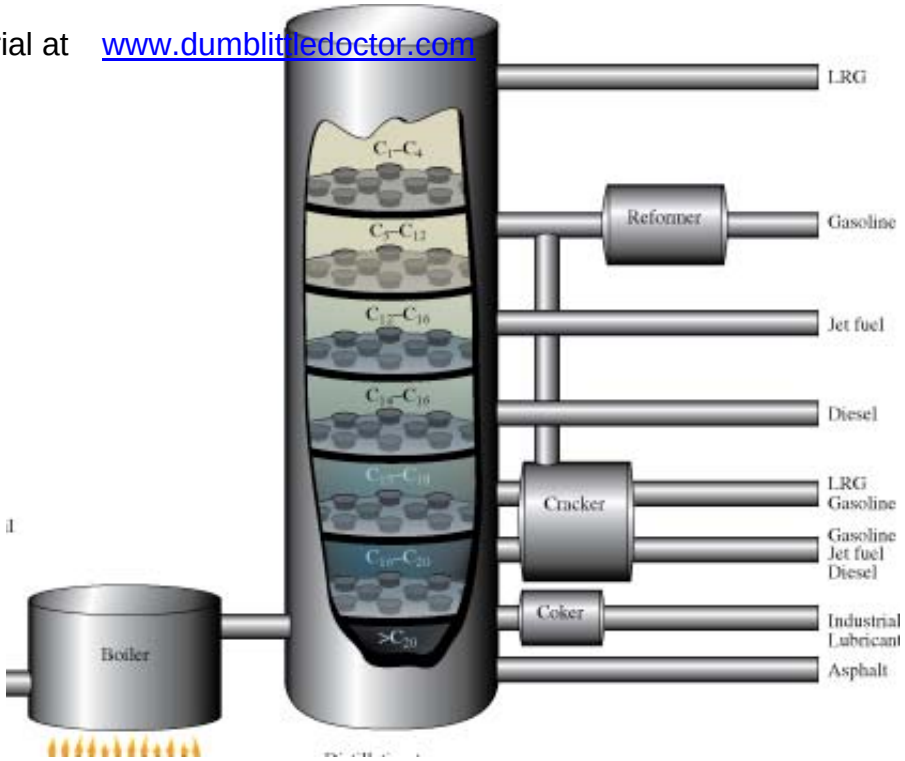
$$\mathbf{3500\ g\ C_6H_{14} \times \frac{1\ mol\ C_6H_{14}}{86\ g\ C_6H_{14}} \times \frac{6\ mol\ CO_2}{1\ mol\ C_6H_{14}} \times \frac{44\ g\ CO_2}{1\ mol\ CO_2} = 10{,}700\ g\ CO_2}$$

C6 = 72
C14 = 14
86

2. (9 points) C_6H_{12} is another component of gasoline. Draw structural formulas for any 3 isomers of C_6H_{12}. Show all bonds and all H atoms.

Structures include cyclohexane, 1-hexene, 2-hexene, and 3-hexene.

+3 if did C6H14 (correctly) instead of C6H12.



Part III. Gasoline
(second part)

Yep, here is a refinery tower from your textbook.

1. (9 points) Fill in the blanks:

Shown at the bottom left of the figure is a pipe. Through it,
___crude oil (or petroleum)___
is fed into the boiler.

This boiler is necessary because heat is required to
__raise the crude oil to its boiling point ("distill it" is OK too)

In the figure, LRG refers to "Liquefied Refinery Gas." Give the name of one of the refinery gases produced that can be liquefied **_ __methane, ethane, propane, or butane.**

2. (3 points) In the U.S., the "cracker" shown on the figure is needed. Explain why in 20 words or less why we choose to crack the heavier fractions in the U.S..

The distillation process does not produce as much gasoline as we use in the U.S. Cracking makes up the difference.

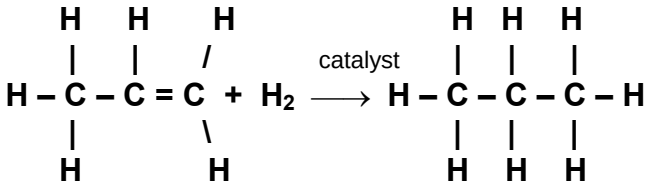
3. (5 points) Speaking of cracking, write a chemical equation that shows how a saturated hydrocarbon molecule containing 16 carbon atoms can be thermally cracked to produce two molecules each with 8 carbon atoms.
Note: Chemical formulas are fine – you don't have to draw out the structures.

$$C_{16}H_{34} \xrightarrow{\text{Heat}} C_8H_{18} + C_8H_{16}$$

4. (3 points) Give one reason that catalytic cracking was an improvement over thermal cracking.

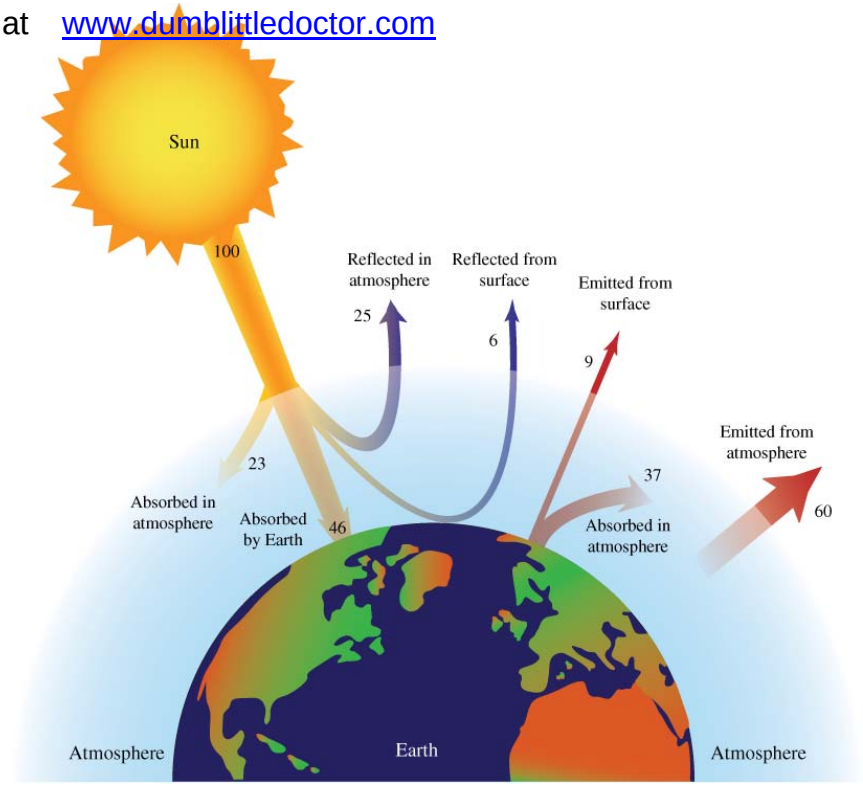
It can be done at a lower temperature (saving energy)
Also, the reaction takes place more quickly (again saving energy)

5. (5 points) Hydro-cracking uses the process of hydrogenation to get rid of the alkenes that can gum up your engine. To save you drawing the big structural formulas for the molecules in gasoline, let's deal with a smaller alkene. Use structural formulas to show the chemical equation for the hydrogenation of **propene**.



Part IV – The Earth as a Greenhouse

The Sun emits UV, visible, and IR radiation. Four arrows on the figure relate to the Sun's emission.



1. (3 points) Explain why much of the UV light emitted by the Sun does not reach the surface of the Earth.
(15 words or less)

The UV is absorbed by O_2 and O_3.

2. (3 points) Other than absorption, explain why a significant amount of the visible light emitted by the Sun does not reach the surface of the Earth. (15 words or less)

The visible light is in the atmosphere reflected by clouds.

3. (6 points) Which of these wavelengths does the Earth (= rock, dirt, ground, pavement) emit? Circle those that apply.

UV visible **IR ONLY**
(+2 for each item)

4. The Greenhouse effect.

a. (3 points) One of the arrows on the figure is primarily responsible for the greenhouse effect. Write the text label that goes with this arrow here:

"Absorbed in atmosphere"

b. (3 points) Using the numerical value on this arrow, explain the term "enhanced greenhouse effect".

The enhanced greenhouse effect occurs when more than 37% of the IR emitted by the Earth is absorbed.

5. (4 points) In the atmosphere, CFCs are present only at the parts per trillion level. Even so, they have a large potential to cause global warming. Explain why.

Yes, CFCs are in parts per trillion. But the wavelength at which they absorb IR is in a region that previously NO other greenhouse gases absorbed. The IR at this wavelength thus previously could escape. With CFCs in the atmosphere, this IR now is absorbed and the heat is retained. FYI, Short Assignment #4 spoke to this point.

Part V – The Carbon Cycle

1. (5 points) Limestone can contain **calcium carbonate**. Write the balanced chemical equation for the action of hydrochloric acid on limestone to release carbon dioxide as one of the products.

$$\mathbf{CaCO_3 + 2HCl \longrightarrow CaCl_2 + CO_2 + H_2O}$$

2. Assume the carbon dioxide released from the limestone is now in the atmosphere.

a. (3 points) The process of **photosynthesis** can **remove** this CO_2 from the atmosphere. The levels of CO_2 decrease in April and May. Why isn't this decrease balanced by an increase in CO_2 from the southern hemisphere (where it is fall, not spring)?

The land mass (with its vegetation) in the northern hemisphere is much larger, so dominates.

b. (3 points) Starting in the springtime, plants store carbon by making **cellulose**. Describe the cellulose molecule (not its uses, but the molecule itself).

It is a big molecule made from smaller molecules of glucose.

c. (3 points) Name one other way that CO_2 is **removed** from the air.

CO_2 is dissolved in bodies of water (mainly oceans)
Reforestation …

4. (4 points) **Respiration** is another process that releases CO_2 into the atmosphere.
Write <u>one sentence</u> describing **respiration** that uses these 4 terms: **glucose CO_2 O_2 energy**

Respiration is the process in our bodies in which we breathe in O_2 and use it to burn foods in our body (such as glucose) to produce CO_2 and release energy.

5. This photo from your text relates to another way that a carbon compound (<u>not</u> CO_2) can be released back into our atmosphere.

a. (2 points) What is pictured and where is it from?
Ice from the polar regions (the Arctic, in this case)

b. (3 points) What carbon compound gets released?
Methane

c. (3 points) When it melts, a feedback loop is set in motion … one that has severe implications for global climate change. <u>Describe the loop</u>.

The LOOP: The ice melts, releases methane, a greenhouse gas, which in turns leads to the melting of more ice, which again releases methane …

Part VI – Global climate change

1. People agree that we are seeing ice loss in the Arctic, both land ice and sea ice.

a. (3 points) People sometimes use the metaphor "the canary in the mine" to make a point. Why is the canary taken into the mine? What is significant about how the canary behaves once there?

Thus canaries were put in the mines before humans entered, and used as an indicator as to whether the air in the mines was safe for humans. The canary will be distressed by low concentrations of oxygen (or the presence of poisonous gases) and perhaps even die.

b. (6 points) Gore points out that the Arctic is "the canary in the mine" when it comes to global climate change. What is significant about how the Arctic behaves? Check the ones that are true.

__**X**__ The Arctic is showing larger changes in average temperature than occur in mid-latitudes.

____ The Arctic ice packs are reflecting sunlight to a greater extent than other ice packs on the planet.

__**X**__ The Arctic is showing larger changes in ecosystems than is occurring at the mid-latitudes.

2. People agree that CO_2 levels are rising in our atmosphere.

a. (3 points) How do we measure CO_2 levels in the atmosphere today?

By spectrophotometry, the same technique you used in lab.

b. (3 points) How did we measure CO_2 levels in the atmosphere thousands of years ago?

By drilling ice cores and measuring the CO2 bubbles trapped in the ice. (See section 3.2 of your text and also the Al Gore film)

c. (3 points) CO_2 levels are rising today because of a combination of two reasons. First, we humans are adding CO_2 to the atmosphere by _**burning fossil fuels**__. Second, the processes that remove CO_2 from the atmosphere __**go at too slow ___of a rate to remove the added CO_2.**_____.