Science-1A Lecture: Week-16, Monday, May 3, 2021

Preparing for Quiz 8 (lots of stuff there)

I'll be passing out Quiz-8 shortly, but don't open them until you have mastered this material.

The practice questions for Quiz 8 are at
https://yosemitefoothills.com/Science-1A/QuizAndTestPractice/SampleQuestions-Quiz-8.pdf
and
https://yosemitefoothills.com/Science-1A/QuizAndTestPractice/SampleQuestions-Quiz-8-Solutions.pdf

You will need to use your Periodic Table of Elements at
https://yosemitefoothills.com/Science-1A/Handouts/Week-09/PeriodicTableOfElements.jpg
for the remainder of the course.

None of the questions in Quiz 8 will need something from the Equation Sheet.

I hope you have been studying my Lecture and Lab Notes at
https://yosemitefoothills.com/Science-1A/#onlineNotes .
They were written with considerable effort to try an make this on-line process easier for you. Nevertheless, below are specific references to them that are applicable to the specific sample questions for Quiz 8.

The answers to **questions 1-6** are apparent from inspection of the Periodic Table because the location of each of the atoms in the Periodic Table is tied to the number of outermost electrons for the atoms, and therefore to the number of bonds. It is assumed here that the molecules being formed with these bonds end up with no net charge; that they are not polyatomic ions.

Atoms in Group 1 will have a single bond since they have a single outer electron which they are happy to give up.
Atoms in Group 2 will have 2 bonds since they have 2 outer electrons which they are happy to give up.
Atoms in Groups 17 will also only have a single bond because they will be happy if they can steal a single electron to complete their outer electron shell.
Oxygen in Group 16 will always have 2 bonds because it is extremely eager to steal 2 electrons from anyone. When oxygen connects to another oxygen, each will still have 2 bonds as a shared double bond.
Sulfur, also in Group 16, will usually have 2 bonds that take 2 electrons to fill its outermost electron shell, but it can sometimes use all 6 of its outermost electrons to have 6 bonds when greedy oxygens are adjacent neighbors.
Nitrogen in Group 15 will normally have 3 bonds that take 3 electrons to fill its outermost electron shell, but it can alternatively use all 5 of its outermost electrons, usually with oxygen partners.
Carbon in Group 14 will always have 4 bonds that it will share with many other atoms to feel that its outermost shell is complete with 8 electrons.

Since Periods 2 and 3 of the Periodic Table have 8 atoms, the sum of electrons that can be taken and those that can be given must be 8. For N and P, we have 3+5=8. For S, we have 2+6=8.

The answers for **questions 7-9 and 11-12** are apparent by imagining construction of the specified molecules using carbon atoms with 4 holes and hydrogen atoms with 1 hole together with the requirement that all holes must be filled. For example, in C_2H_6, the C's have 4 holes each for a total of 8 holes, 6 of which must connect to the 6 H's. As a result, a single bond must connect the 2 C's. In C_2H_2, by contrast, only one hole in each C is used by a bond to an H so that a triple bond must connect the remaining 3 holes of each C.

For benzene C_6H_6 and cyclohexane C_6H_{12}, you must recall that they have ring structures as was discussed on page 5 of
https://yosemitefoothills.com/Science-1A/OnlineLectureAndLabNotes/Week-09-Lab-Wednesday-March-10-2021.pdf
and was shown on the page 1 of the Molecular Diagrams at
https://yosemitefoothills.com/Science-1A/Handouts/Week-09/AllMolecularStructureImages.pdf .
Benzene has only 1 H per C so that each C must have 3 bonds when connecting to its adjacent C's in the ring. This forces alternate double and single bonds which can also be written as a circle inside of a hexagon.

Cyclohexane C_6H_{12}, however, has 12 H's so it only has single bonds to its neighboring carbons in its hexagonal ring.

Check out the animations of benzene and cyclohexane at
https://yosemitefoothills.com/Science-1A/MolecularAnimations/ .

Isomers have the same set of atoms, but different structures. Propanol-1 and isopropyl alcohol both have the C_3H_8O formula, but the iso version has the OH in the middle and propanol-1 has it at an end. **Isomers** are very common and have quite different chemical properties. **Question 10** checks if you recall that term.

Question 13 can be remembered if you can remember that petroleum molecules have single bonds between their carbons, each carbon has 4 bonds, and each hydrogen has only one bond. If you try to draw them, you are forced to draw CH_4, C_2H_6, C_3H_8, C_4H_{10}, etc. CH_4 can have 4 hydrogens, but each additional carbon only allows room for 2 more hydrogens. So the general formula is C_nH_{2n+2} . Check and see that that formula produces the petroleum molecules mentioned above when n=1, 2, 3, and 4.

The discussion about fatty acids at
*https://yosemitefoothills.com/Science-1A/OnlineLectureAndLabNotes/*Week-11-Lab-Wednesday-March-24-2021.pdf
covers **questions 14 and 24**.

The answer to **question 15** is clear if you imagine a single bond being like an axle between two wheels, but a double bond is like a pair of rigid rods connecting two parts. The wheels can rotate in the first case, but the parts cannot rotate in the second case.

The answer to **questions 16 and 20** are from our discussion of how amino acids connect together to make an arbitrarily-long chain. There, we noted that a water molecule was discarded when each connection (called a peptide bond) was made. The discussion of fatty acids noted that water molecules are also freed when triglycerides were formed.

The background for **questions 17 and 18** was provided in the handout at
https://yosemitefoothills.com/Science-1A/OnlineLectureAndLabNotes/Week-09-Lab-Wednesday-March-10-2021.pdf
The animated gifs for water and carbon dioxide are at
https://yosemitefoothills.com/Science-1A/MolecularAnimations/
Notice how the double bonds force carbon dioxide to be linear (no bends).:

Questions 19-22 deal with **functional groups** which are the parts of biological molecules that are most likely to connect to other molecules. Some are listed at
https://yosemitefoothills.com/Science-1A/Handouts/Week-13/FunctionalGroups.pdf .
Hydroxyl and **carboxyl** functional groups form the connections making triglycerides from glycerol and fatty acids. **Hydroxyl** and **amine** functional groups form the 8 amino acid junctions in oxytocin. Alcohols are characterized by simple molecules with a **hydroxyl** functional group. Many molecules that have a fruit taste and smell have **ester** functional groups.

Question 23 is about a fun demonstration where acetone is squirted into a Styrofoam cup. After a few seconds, the bottom falls out in a gooey mess. Lately, that has not worked for me; the construction of Styrofoam cups seems to have changed.

The fascinating background for **questions 25-27** was discussed in the notes at
https://yosemitefoothills.com/Science-1A/OnlineLectureAndLabNotes/Week-12-Lab-Wednesday-April-7-2021.pdf .

The topic of **question 28**, DNA, was discussed at
https://yosemitefoothills.com/Science-1A/OnlineLectureAndLabNotes/Week-13-Lecture-Friday-April-16-2021.pdf .
The nucleic acids have lots of nitrogen atoms and the DNA backbone has phosphorus atoms.

I have not said anything about the plastics shown on page 4 of our Molecular Diagrams handout at
https://yosemitefoothills.com/Science-1A/Handouts/Week-09/AllMolecularStructureImages.pdf .
Some, like Nylon 6,6 are formed by amine-hydroxyl junctions (like in oxytocin) which free a water, many others are formed by breaking a double bond to make a connection to the next molecule in the polymer. These are shown at the bottom of that page and give the answer to **question 29**.

Finally, **all the remaining questions** are answered in the handout at
https://yosemitefoothills.com/Science-1A/OnlineLectureAndLabNotes/Week-15-Lab-Wednesday-Friday-April-28-30-2021.pdf
and its link to
https://yosemitefoothills.com/Science-1A/Handouts/Week-14/NuclearReactions.pdf ,
and its links to the Disney “Our Friend the Atom” and the nuclear disaster videos.