Name: ______________________

Part 1: Structural Isomers of Pentane

Background

We encounter a variety of hydrocarbons, compounds that consist only of carbon and hydrogen, in our daily life. These compounds may have only single bonds (alkanes), at least one double bond (alkenes), or at least one triple bond (alkynes).

Alkanes have the general molecular formula \( C_nH_{2n+2} \). In these molecules, each carbon atom can bond to 4 different atoms (either carbon or hydrogen) and each hydrogen can only bond to 1 other atom (which must be carbon). Alkanes are commonly referred to as saturated compounds because the molecule has the maximum possible number of hydrogen atoms relative to number of carbons present.

Gasoline is a complex mixture of hydrocarbons of all types, and is often characterized by its octane number. The octane number is a means to relate the combustion properties of the fuel to a standard, isooctane, \( C_8H_{18} \), with an octane number of 100. The octane number you see at the pump doesn’t actually represent the amount of octane in the fuel, but rather the combustion behavior of the fuel in an engine as compared to isooctane.

Isooctane is the common name; the systematic IUPAC name for this molecule is 2,2,4-trimethylpentane, and it can be represented symbolically in several ways as shown below:

<table>
<thead>
<tr>
<th>Displayed Formula</th>
<th>Structural Formula</th>
<th>Skeletal (line-angle) Formula</th>
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<tbody>
<tr>
<td><img src="image1" alt="Displayed Formula" /></td>
<td><img src="image2" alt="Structural Formula" /></td>
<td><img src="image3" alt="Skeletal Formula" /></td>
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</tbody>
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As all bonds and atoms are shown in the displayed formula, it looks cluttered. For clarity, chemists use either the structural formula (which shows all atoms but simplifies the representation of carbon-hydrogen bonds) or the skeletal formula. The skeletal formula does not explicitly show each C and H atoms; it is understood that each vertex or line terminus represents a carbon atom. The number of hydrogen atoms attached to each carbon atom is equal to 4 - # of lines shown (because each carbon atom can only make a total of 4 bonds).

Isooctane is a branched alkane; that is, it is not linear. The same 8 carbon and 18 hydrogen atoms can be arranged in a straight line to make n-octane:
Isooctane and n-octane have the same atoms and molecular formula but differ in the arrangement of these atoms; they are structural or constitutional isomers, and are different chemical compounds with different chemical properties.

**Problem**
How many different ways can 5 carbon atoms and 12 hydrogen atoms be arranged to form an alkane (how many structural isomers of pentane are there)? Do the different isomers have the same physical properties? How might different isomers be separated from each other?

There are 3 different structural isomers for $\text{C}_5\text{H}_{12}$. Draw them. You may find it most convenient to use the structural or skeletal formula.