Mini Lab: Organic Smells

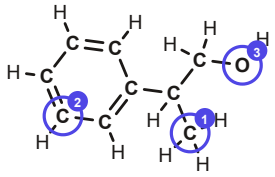
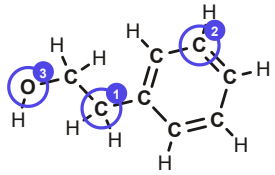
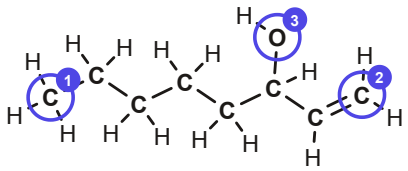
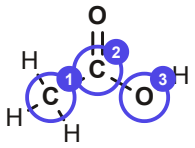
WHAT STUDENTS DO, FOR EACH VIAL

1. Waft and write a smell hypothesis in their own words.
2. Find every different molecular geometry in the molecule.
3. Circle and number one example of each geometry on the structure.
4. List each number with its geometry name.

Circles mark one representative center per geometry. Any correct center of the same type earns full credit.

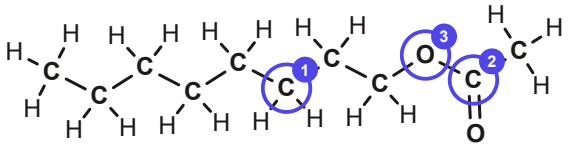
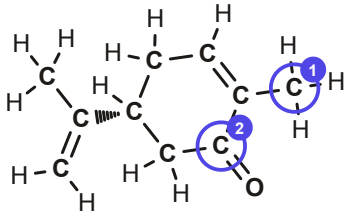
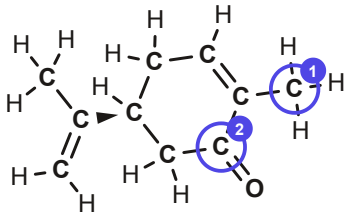
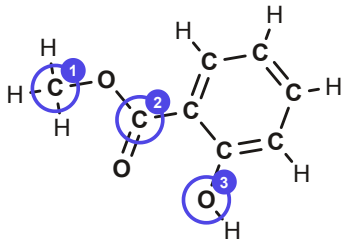
How the key was built. Conventional VSEPR, lone pairs counted. Carbon with four bonds: tetrahedral. Carbon with a double bond (carbonyl, alkene, aromatic): trigonal planar. Oxygen with two bonds and two lone pairs: bent. Hydrogens and carbonyl oxygens are terminal atoms, not centers. Notes and the F and G discussion are on the last page.

Safety. Goggles on. Students waft, never sniff from the vial, and never touch or taste a sample. Cap vials immediately. Good ventilation. A student who cannot or should not smell the vials works from the structures and a partner's descriptions.

VIAL	COMPOUND NAME	ORGANIC STRUCTURE	SMELL HYPOTHESIS	MOLECULAR GEOMETRIES
A	**2-Phenylpropanol** $C_9H_{12}O$		**Hyacinth**	1. Tetrahedral 2. Trigonal planar 3. Bent
B	**2-Phenylethanol** $C_8H_{10}O$		**Roses**	1. Tetrahedral 2. Trigonal planar 3. Bent
C	**1-Octen-3-ol** $C_8H_{16}O$		**Mushroom**	1. Tetrahedral 2. Trigonal planar 3. Bent
D	**Acetic acid (5% aqueous)** $C_2H_4O_2$		**Vinegar**	1. Tetrahedral 2. Trigonal planar 3. Bent

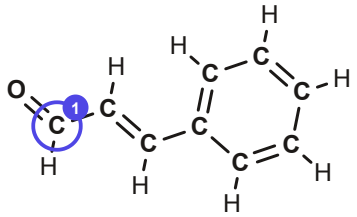
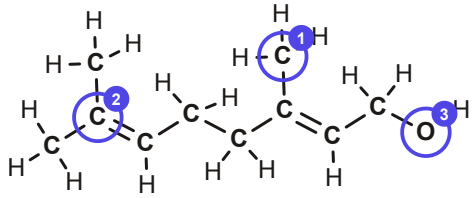
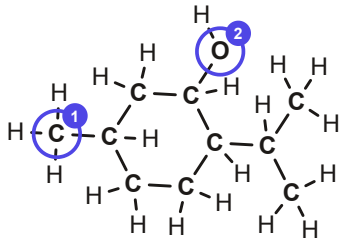
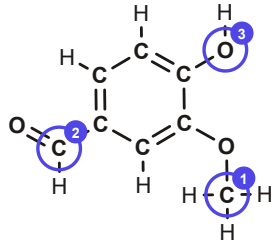
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Name _____

VIAL	COMPOUND NAME	ORGANIC STRUCTURE	SMELL HYPOTHESIS	MOLECULAR GEOMETRIES
E	**Octyl acetate** $C_{10}H_{20}O_2$		**Orange**	1. Tetrahedral 2. Trigonal planar 3. Bent
F	**(R)-Carvone** $C_{10}H_{14}O$		**Spearmint**	1. Tetrahedral 2. Trigonal planar
G	**(S)-Carvone** $C_{10}H_{14}O$		**Caraway**	1. Tetrahedral 2. Trigonal planar
H	**Methyl salicylate** $C_8H_8O_3$		**Wintergreen**	1. Tetrahedral 2. Trigonal planar 3. Bent

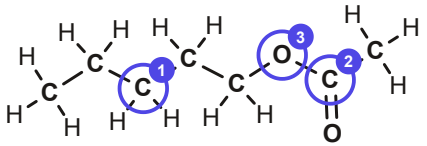
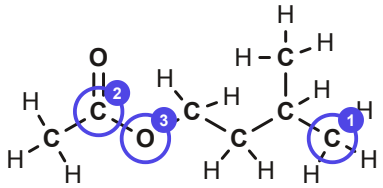
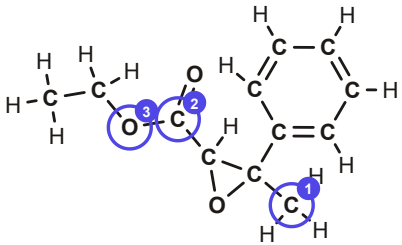
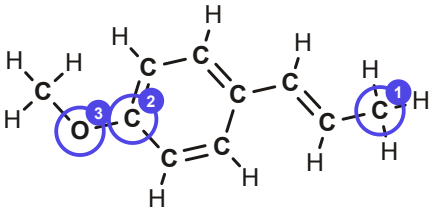
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Name _____

VIAL	COMPOUND NAME	ORGANIC STRUCTURE	SMELL HYPOTHESIS	MOLECULAR GEOMETRIES
I	**trans-Cinnamaldehyde** C_9H_8O		**Cinnamon**	1. Trigonal planar
J	**Geraniol** $C_{10}H_{18}O$		**Geraniums**	1. Tetrahedral 2. Trigonal planar 3. Bent
K	**Menthol** $C_{10}H_{20}O$		**Peppermint**	1. Tetrahedral 2. Bent
L	**Vanillin** $C_8H_8O_3$		**Vanilla**	1. Tetrahedral 2. Trigonal planar 3. Bent

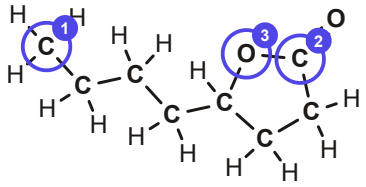
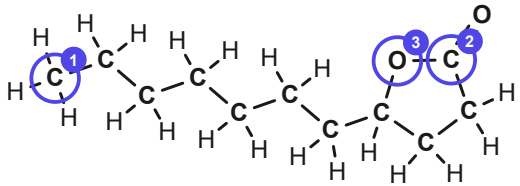
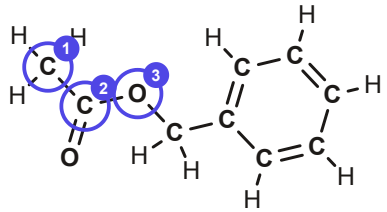
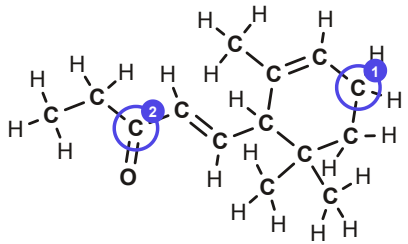
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Name _____

VIAL	COMPOUND NAME	ORGANIC STRUCTURE	SMELL HYPOTHESIS	MOLECULAR GEOMETRIES
M	**Amyl acetate** $C_7H_{14}O_2$		**Banana**	1. Tetrahedral 2. Trigonal planar 3. Bent
N	**Isoamyl acetate** $C_7H_{14}O_2$		**Pear**	1. Tetrahedral 2. Trigonal planar 3. Bent
O	**Ethyl methylphenylglycidate** $C_{12}H_{14}O_3$		**Strawberry**	1. Tetrahedral 2. Trigonal planar 3. Bent
P	**Anethole** $C_{10}H_{12}O$		**Licorice**	1. Tetrahedral 2. Trigonal planar 3. Bent

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Name _____

VIAL	COMPOUND NAME	ORGANIC STRUCTURE	SMELL HYPOTHESIS	MOLECULAR GEOMETRIES
Q	**gamma-Octanoic lactone** $C_8H_{14}O_2$		**Coconut**	1. Tetrahedral 2. Trigonal planar 3. Bent
R	**gamma-Undecanoic lactone** $C_{11}H_{20}O_2$		**Peach**	1. Tetrahedral 2. Trigonal planar 3. Bent
S	**Benzyl acetate** $C_9H_{10}O_2$		**Jasmine**	1. Tetrahedral 2. Trigonal planar 3. Bent
T	**6-Methylionone** $C_{14}H_{22}O$		**Violets**	1. Tetrahedral 2. Trigonal planar

Teacher notes

VIALS F AND G: THE CARVONES

(R)-Carvone and (S)-Carvone share one molecular formula, $C_{10}H_{14}O$, and identical connectivity. They differ only at the ring carbon bonded to the isopropenyl group, drawn with a wedge in one and a hash in the other. The (R) form smells like spearmint and the (S) form like caraway, which matches Flinn's table and the published chemistry. Their VSEPR geometries are identical, so this pair is the clearest case that local geometry alone does not decide smell: the three-dimensional arrangement of the whole molecule, and how it fits an odor receptor, matters too.

GEOMETRY DECISIONS WORTH SAYING OUT LOUD

- Aromatic ring carbons are trigonal planar. The alternating double bonds are one accepted drawing of a delocalized ring, and conventional VSEPR treats each ring carbon as having three electron groups.
- Ester and acid oxygens that sit between two atoms (the C-O-C or C-O-H oxygen) are bent. The carbonyl oxygen is a terminal atom and is not a center.
- Ring oxygens in the lactones (Q and R) and the epoxide (O) are bent by the same rule. Ring strain changes the angle, not the VSEPR name.
- trans-Cinnamaldehyde (I) contains only trigonal planar centers. Menthol (K) has no double bond, so it shows only tetrahedral and bent. The carvones (F, G) and 6-Methylionone (T) have no oxygen with two bonds, so bent does not appear.
- No molecule in the kit has a linear center.

PEDAGOGY

Keep the focus on observing and annotating. Students should notice that one molecule contains several local geometries, and that molecules with similar geometries can smell nothing alike. Do not claim that VSEPR geometry explains odor. Shape, stereochemistry, functional groups, volatility, and receptor interactions all contribute.

RUNNING THE LAB

- Flinn kit AP1566, vials A to T. The vial order in this key follows Flinn's table.
- Project the companion app and reveal the name, the odor, and the geometries one vial at a time after students commit to their own answers.
- Acetic acid (D) is the 5% aqueous solution from the kit.
- If a physical vial label ever differs from this key, edit data/compounds.json in the project folder and rebuild. The worksheet, this key, and the app all read the same file.

ALTERNATIVE OBSERVATION ARRANGEMENT

A student with asthma, migraines, pregnancy, scent sensitivity, or a cold can complete the lab without smelling anything. Pair them with a partner who wafts and describes each sample. The structural work in columns three and five is the same for everyone.