

SI Chemistry - Full Discipline Demo

Functional Groups in Organic Chemistry

Final Report - Answer Guide

Institution	Science Interactive University
Session	SI Chemistry - Full Discipline Demo
Course	SI Chemistry - Full Discipline Demo
Instructor	Sales SI Demo

Test Your Knowledge

Categorize each element by the number of potential bonds formed in compounds according to the octet rule.

	1	2	3	4
☐ Bromine				
☐ Carbon				
☐ Chlorine				
☐ Hydrogen				
☐ Nitrogen				
☐ Oxygen				
☐ Sulfur				

Correct answers:

- | | | | | | | |
|---|----------|----------|----------|---|--------|--------|
| 1 | Bromine | Chlorine | Hydrogen | 2 | Oxygen | Sulfur |
| 3 | Nitrogen | 4 | Carbon | | | |

Match each functional group with the correct structure.

⚡ Alcohol

⚡ Aldehyde

⚡ Alkene

⚡ Alkyne

⚡ Amide

⚡ Amine

$$\begin{array}{c} \text{NH}_2 \\ | \\ \text{CH}_3 - \text{CH} - \text{CH}_3 \end{array}$$

1

$$\text{CH}_3 - \text{CH}_2 - \text{C} \equiv \text{C} - \text{CH}_2 - \text{CH}_2 - \text{CH}_3$$

2

$$\begin{array}{c} \text{O} \\ || \\ \text{CH}_3\text{CH}_2\text{CH}_2\text{CNH}_2 \end{array}$$

3

$$\text{CH}_2 = \text{CH} - \text{CH}_2 - \text{CH}_2 - \text{CH}_2 - \text{CH}_3$$

4

$$\begin{array}{c} \text{OH} \\ | \\ \text{CH}_3 - \text{CH} - \text{CH}_2 - \text{CH} - \text{CH}_2 - \text{CH}_2 - \text{CH}_3 \\ | \\ \text{CH}_2\text{CH}_3 \end{array}$$

5

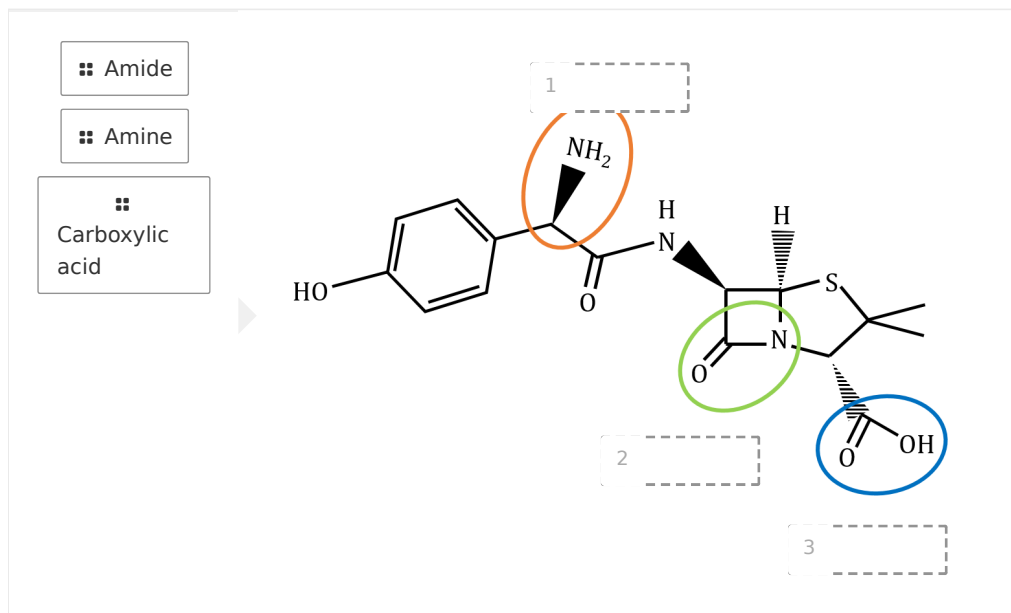
$$\begin{array}{c} \text{CH}_3 \quad \text{O} \\ | \quad || \\ \text{CH}_3\text{CH}_2\text{CHCH}_2\text{CH} \end{array}$$

6

Correct answers:

- 1 Amine 2 Alkyne 3 Amide 4 Alkene 5 Alcohol
6 Aldehyde

Label the circled sections of the image with the correct functional group.



Correct answers:

1 Amine 2 Amide 3 Carboxylic acid

Exploration

Hydrocarbons are the simplest organic compounds, named based on the number of carbon atoms in the longest chain.

☐ True



☐ False

An organic compound with seven carbons in the longest continuous chain has the prefix ____.

☐ hex-

☐ hept-



☐ oct-

☐ but-

_____ include a carbon-oxygen-carbon linkage.

- ☐ Alcohols
- ☒ Ethers ✓
- ☐ Amines
- ☐ Thiols

Carboxylic acids combine a(n) _____.

- ☒ carbonyl and a hydroxyl group ✓
- ☐ ketone
- ☐ aldehyde and a hydroxyl group
- ☐ carbonyl and a thiol

_____ contain a carbonyl group with a carbon-nitrogen bond.

- ☐ Esters
- ☒ Amides ✓
- ☐ Amines
- ☐ Aldehydes

Ketones are named with the suffix _____.

- ☐ -oic acid
- ☐ -al
- ☐ -ol
- ☒ -one ✓

Based on the priority of functional groups in naming organic compounds, ____ is given priority over ____.

- ☒ amide; amine
- ☐ ketone; amide
- ☐ thiol; ketone
- ☐ ether; ester



Exercise 1

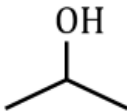
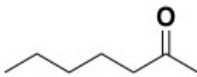
Compare and contrast the following pairs of functional groups:

- a. Alcohols and ethers
- b. Aldehydes and ketones
- c. Amines and amides
- d. Carboxylic acids and alcohols
- e. Amides and esters
- f. Ethers and esters

- a) Alcohol and ethers – Both contain C-O bonds. Alcohols contain a C-O-H group while ethers contain a C-O-C group.
- b) Aldehydes and ketones – Both contain carbonyl groups, $>C=O$, but differ in the location. If the carbonyl carbon is at the end of a chain of carbon atoms and bonded to an H as well, then it is an aldehyde. If the carbonyl carbon is bonded to two other carbon atoms, then it is a ketone.
- c) Amines and amides – Both contain C-N bonds. In the case of an amide, the C is also part of a carbonyl group.
- d) Carboxylic acids and alcohols – Both contain C-OH bonds but the C is also part of a carbonyl group in carboxylic acids.
- e) Amides and esters – Both contain carbonyl groups, with the carbonyl carbon bonded to something other than C or H. In amides, the carbonyl carbon is bonded to N while in esters, the carbonyl carbon is bonded to an O-C group.
- f) Ethers and esters – Both contain C-O-C groups. In esters, one of the Cs in the group is a carbonyl carbon.

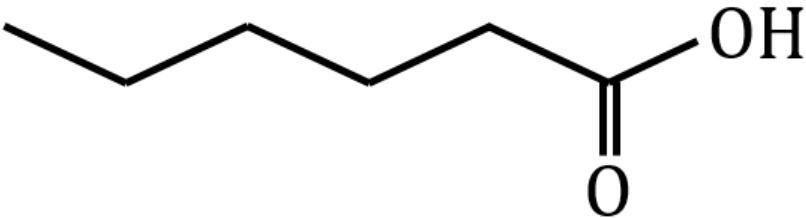
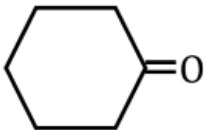
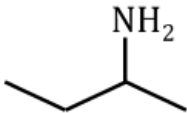
Compare the structure and listed name for each compound shown in Table 5. Record “Yes” if the structure is accurately named, or record the correct name if the structure is incorrectly named in Table 5.

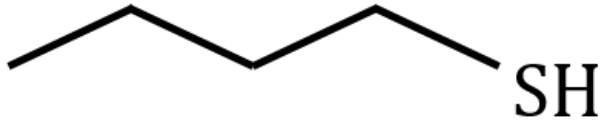
Table 5. Identifying the Correct Name of Compounds

Number	Structure	Name
1	$\text{CH}_3-\text{CH}_2-\text{CH}_2-\text{CH}_2-\overset{\text{O}}{\underset{\parallel}{\text{C}}}-\text{OH}$	Pentanoic acid
2		2-propanal
3	$\begin{array}{ccccccc} & \text{O} & \text{H} & & & & \\ & \parallel & & & & & \\ \text{H}_3\text{C}- & \text{C} & -\text{C} & -\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_3 \\ & & & & & & \\ & & \text{CH}_3 & & & & \end{array}$	2-methyl-3-octanone
4	$\text{CH}_3-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{OH}$	1-butanol
5		hexanone
6	$\begin{array}{c} \text{NH}_2 \\ \\ \text{H}_3\text{C}-\text{C}-\text{CH}_2-\text{CH}_3 \\ \\ \text{H} \end{array}$	1-propanamide

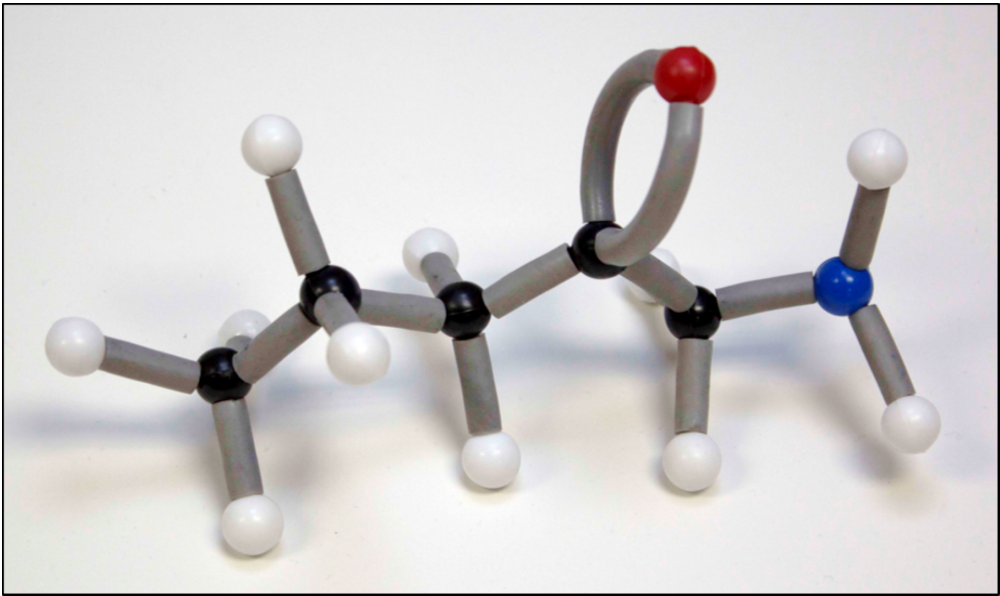
1. Yes
2. 2-propanol
3. 3-methyl-2-octanone
4. Yes
5. 2-heptanone
6. 2-butanamine

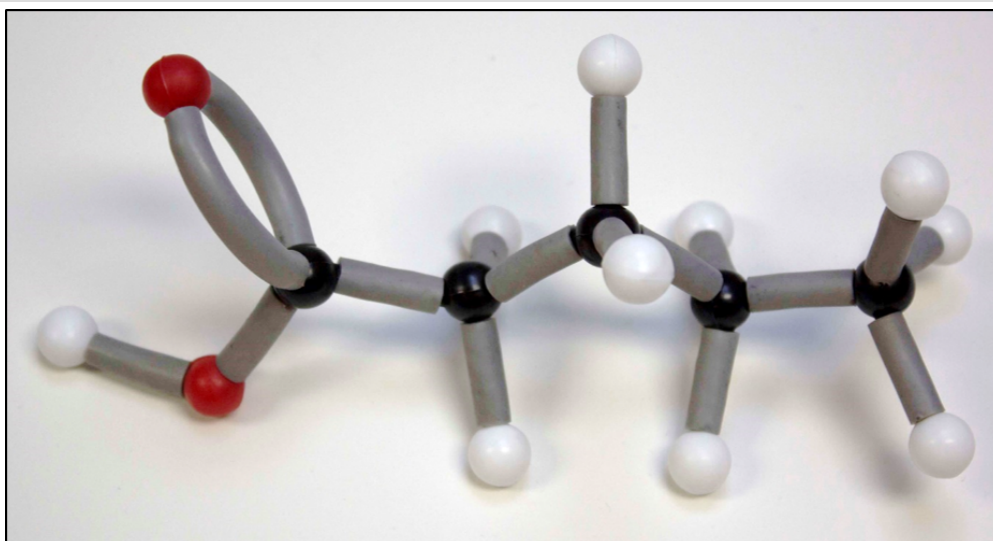
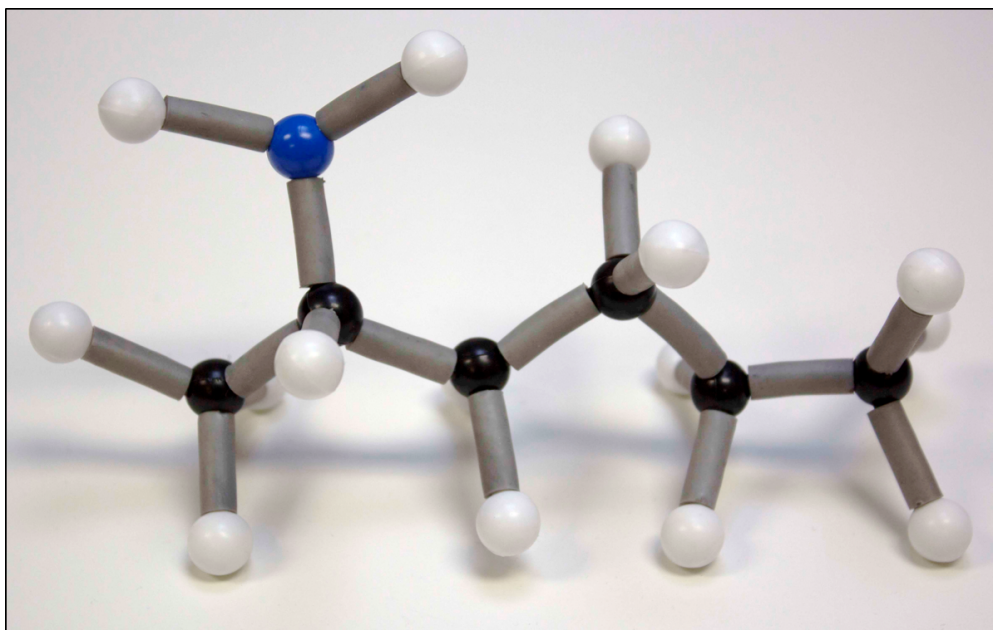
Data Table 1: Naming Functional Groups and Compound Names Based on Structure
(SAMPLE ANSWER BELOW)

Structure	Functional Group	Compound Name
$\text{CH}_2=\text{CH}-\text{CH}_2-\text{CH}_2-\text{CH}_3$	Alkene	1-pentene
	Carboxylic acid	Hexanoic acid
$\text{CH}_3\text{CH}_2\text{CH}_2\overset{\text{O}}{\parallel}\text{CONH}_2$	Amide	Butanamide
	Ketone	Cyclohexanone
$\text{CH}_2-\text{CH}_2-\text{C}\equiv\text{C}-\text{CH}_2-\text{CH}_2-\text{CH}_3$	Alkyne	3-heptyne
	Amine	2-butanamine
	Ester	

$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\overset{\text{O}}{\parallel}\text{COCH}_2\text{CH}_3$		
	Thiol	

Data Table 2: Naming Functional Groups Based on Molecular Models
(SAMPLE ANSWER BELOW)

Model	Molecular Model	Functional Group
A		Ketone
B		Amine

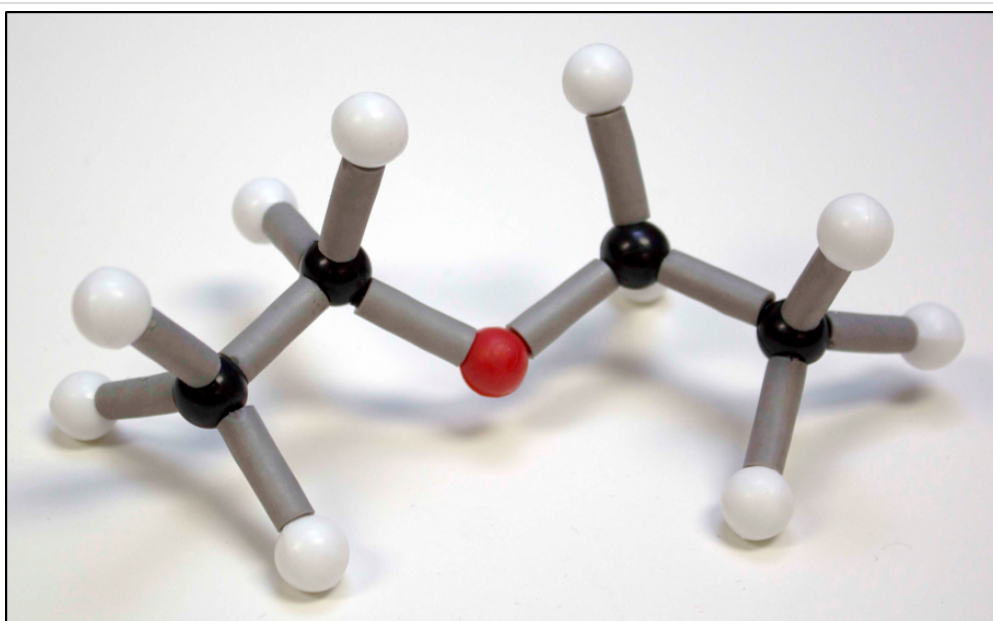
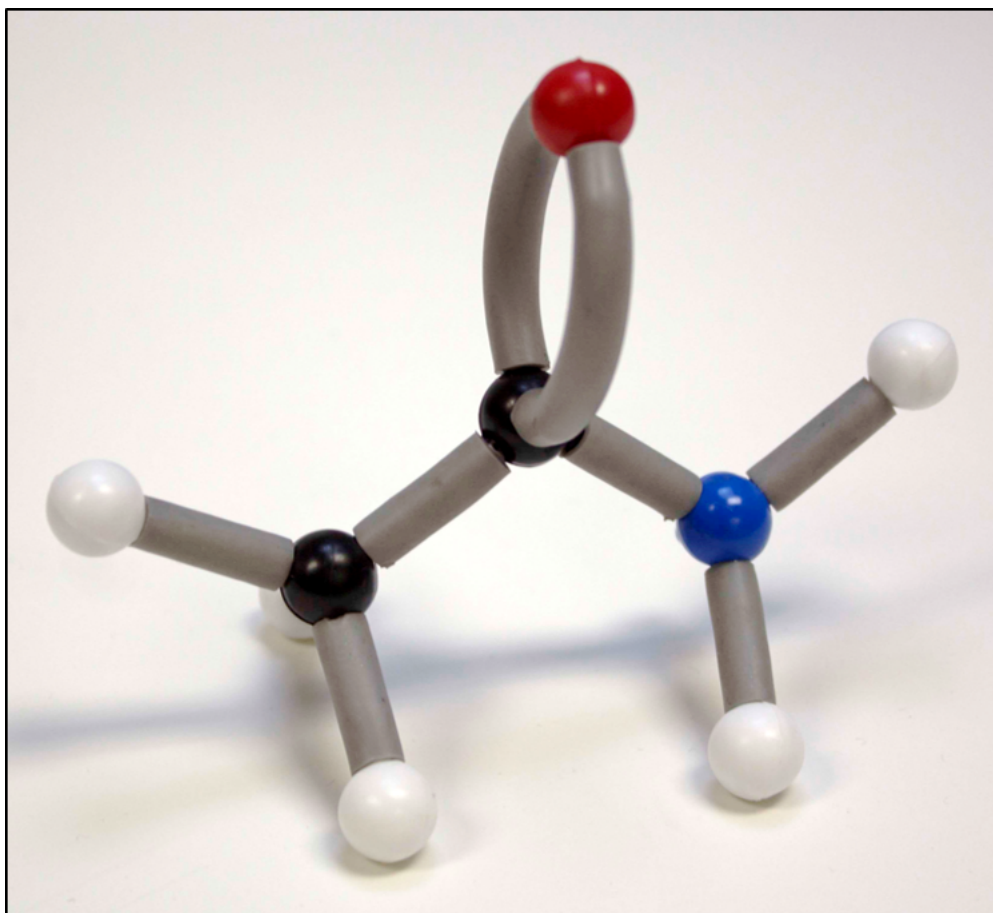


C

Carboxylic acid

D

Amide

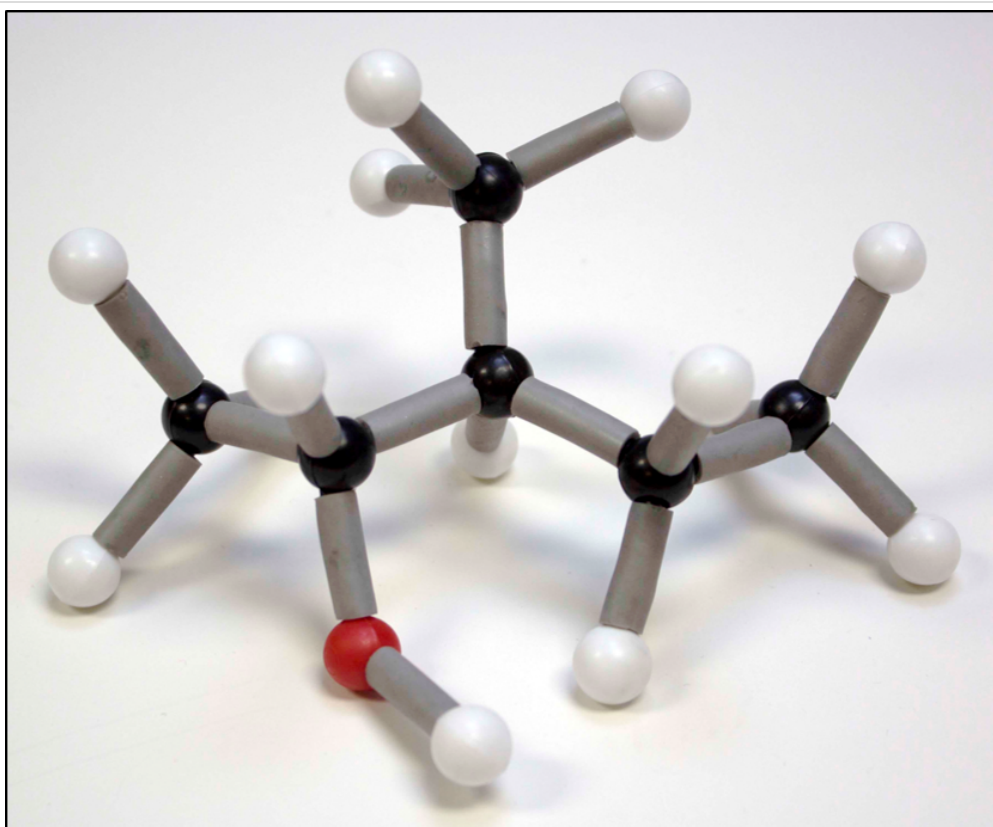
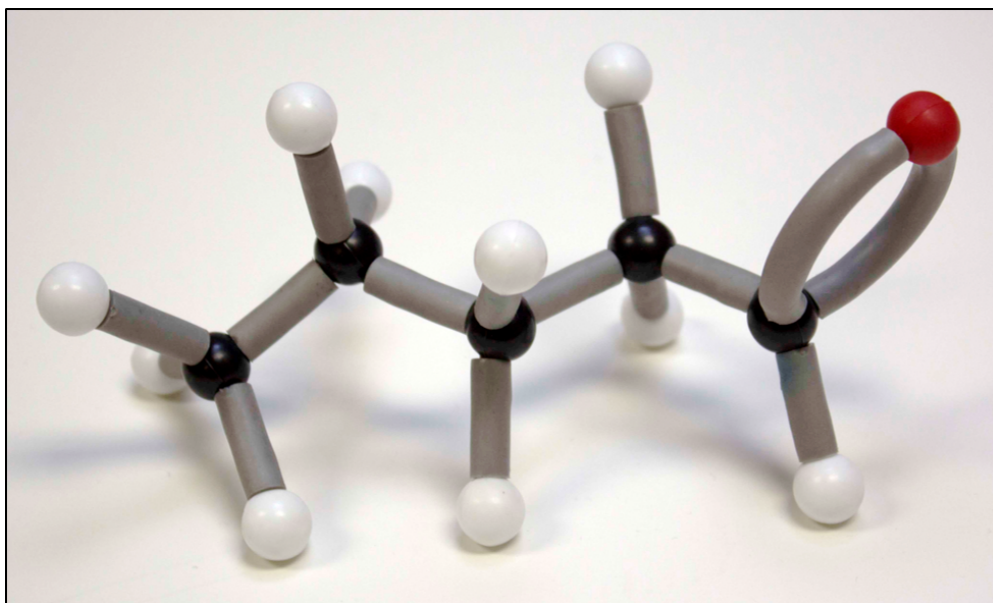


E

Ether

F

Aldehyde



G

Alcohol

H

Ester

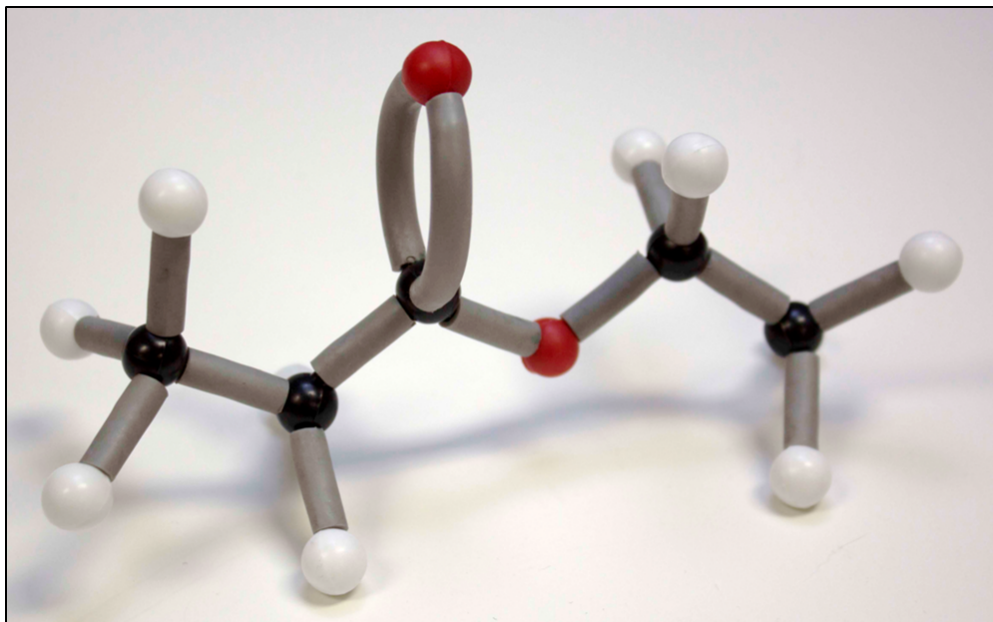


Photo 1: Model A – Structural Formula
(SAMPLE ANSWER BELOW)

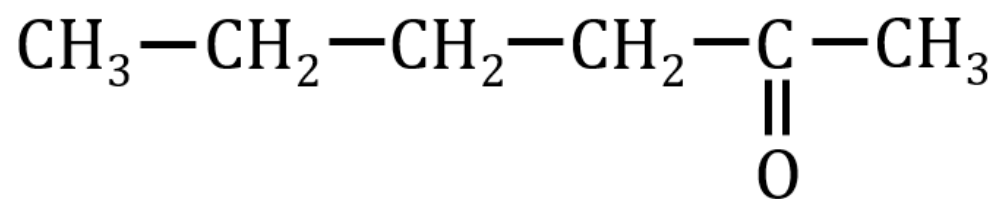


Photo 2: Model B – Structural Formula
(SAMPLE ANSWER BELOW)

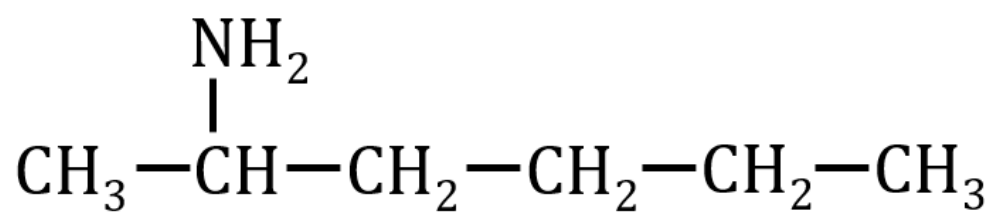


Photo 3: Model C – Structural Formula
(SAMPLE ANSWER BELOW)

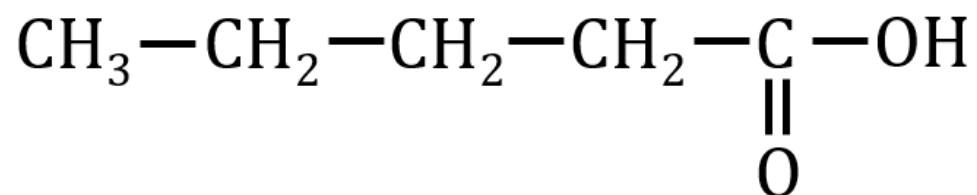


Photo 4: Model D – Structural Formula
(SAMPLE ANSWER BELOW)

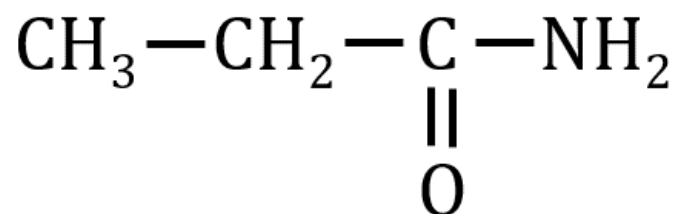


Photo 5: Model E – Structural Formula
(SAMPLE ANSWER BELOW)

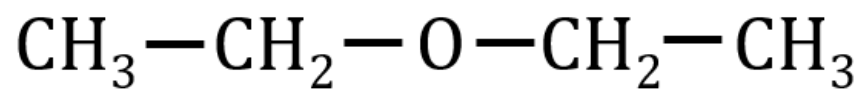


Photo 6: Model F – Structural Formula
(SAMPLE ANSWER BELOW)

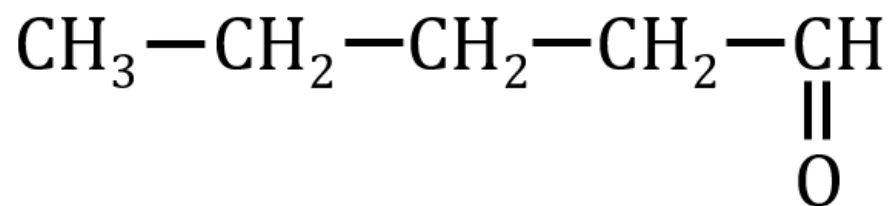


Photo 7: Model G – Structural Formula
(SAMPLE ANSWER BELOW)

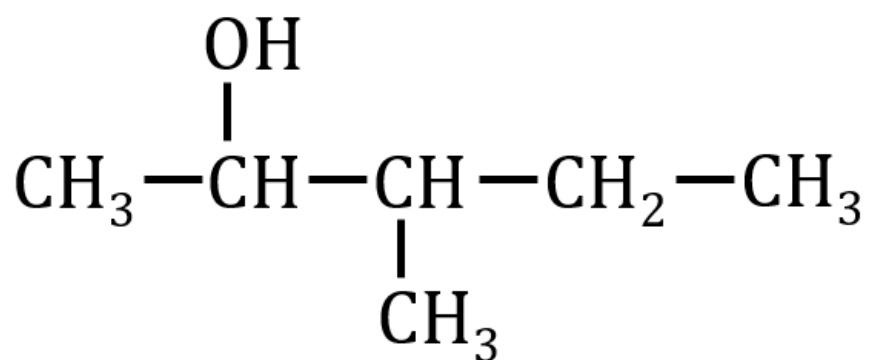
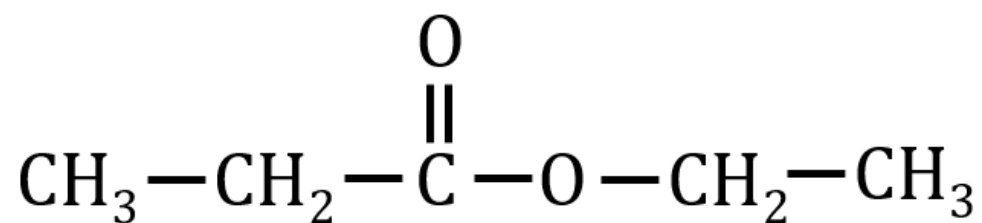


Photo 8: Model H – Structural Formula
(SAMPLE ANSWER BELOW)



Data Table 3: Naming Functional Groups Based on the IUPAC Name
(SAMPLE ANSWER BELOW)

Name	Functional Group
Propanoic acid	Carboxylic acid

3-methylpentanal	Aldehyde
2,3-dimethyl-1-hexene	Alkene
2-propanamine	Amine
Ethanamide	Amide
4-ethyl-2-heptanol	Alcohol
3-methyl-2-octanone	Ketone
1,2-dichloroethylpropanoate	Ester

Photo 9: Propanoic Acid - Structural Formula
(SAMPLE ANSWER BELOW)

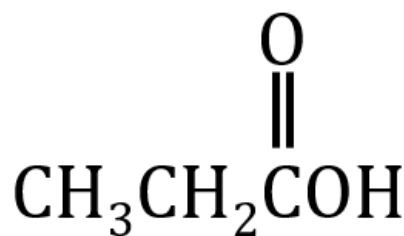


Photo 10: Propanoic Acid – Molecular Model
(SAMPLE ANSWER BELOW)

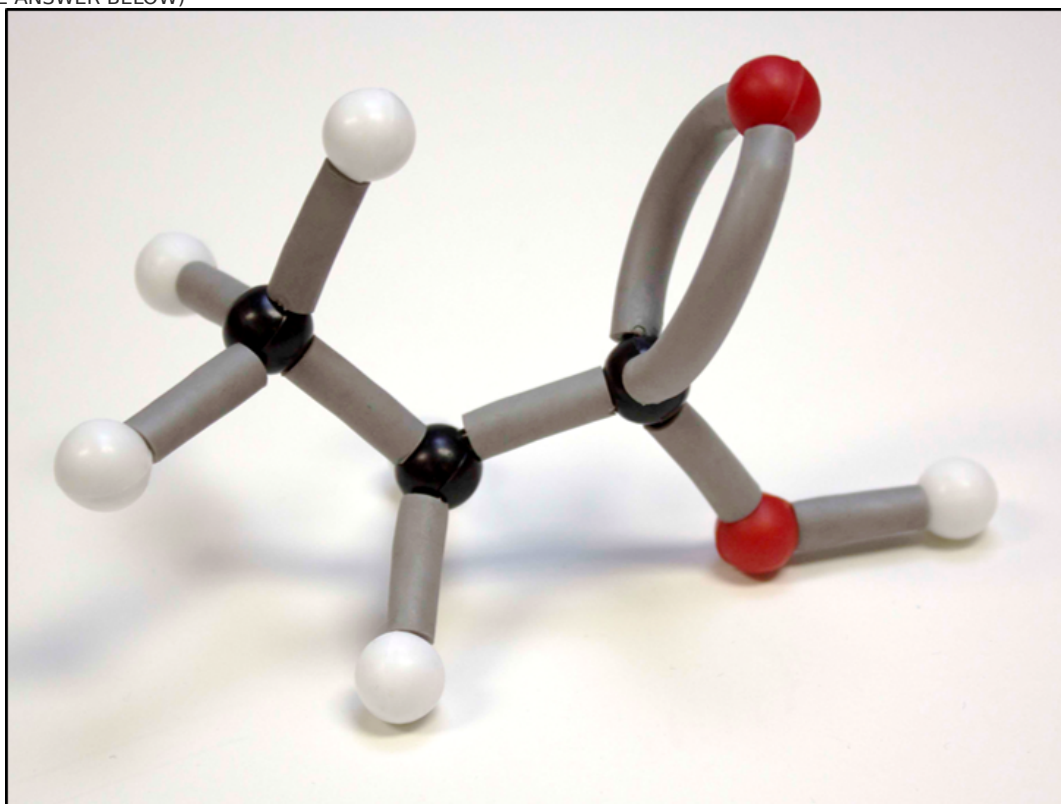


Photo 11: 3-methylpentanal – Structural Formula
(SAMPLE ANSWER BELOW)

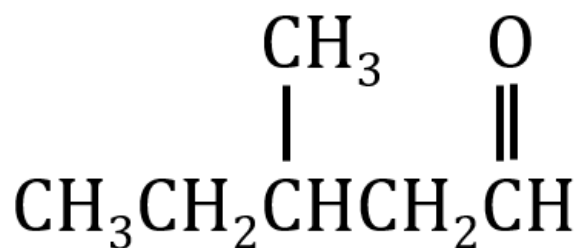


Photo 12: 3-methylpentanal – Molecular Model
(SAMPLE ANSWER BELOW)

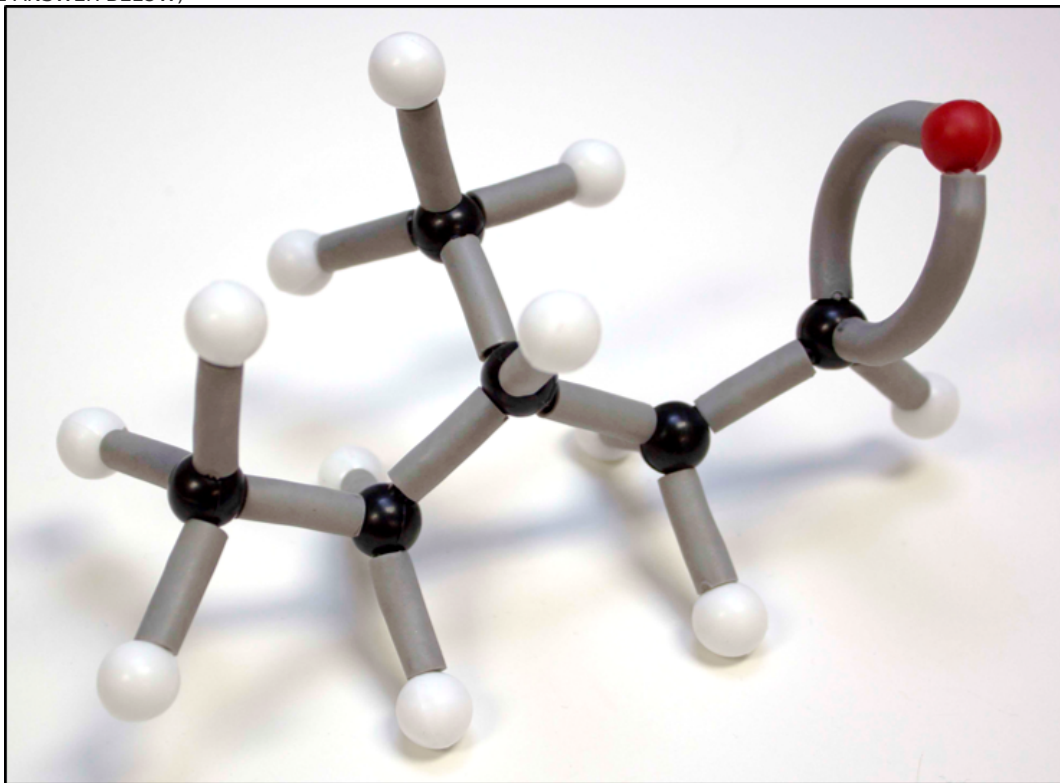


Photo 13: 2,3-dimethyl-1-pentene – Structural Formula
(SAMPLE ANSWER BELOW)

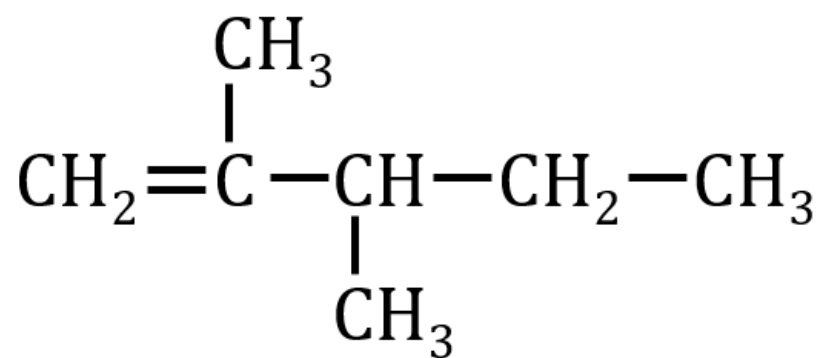


Photo 14: 2,3-dimethyl-1-hexene – Molecular Model
(SAMPLE ANSWER BELOW)



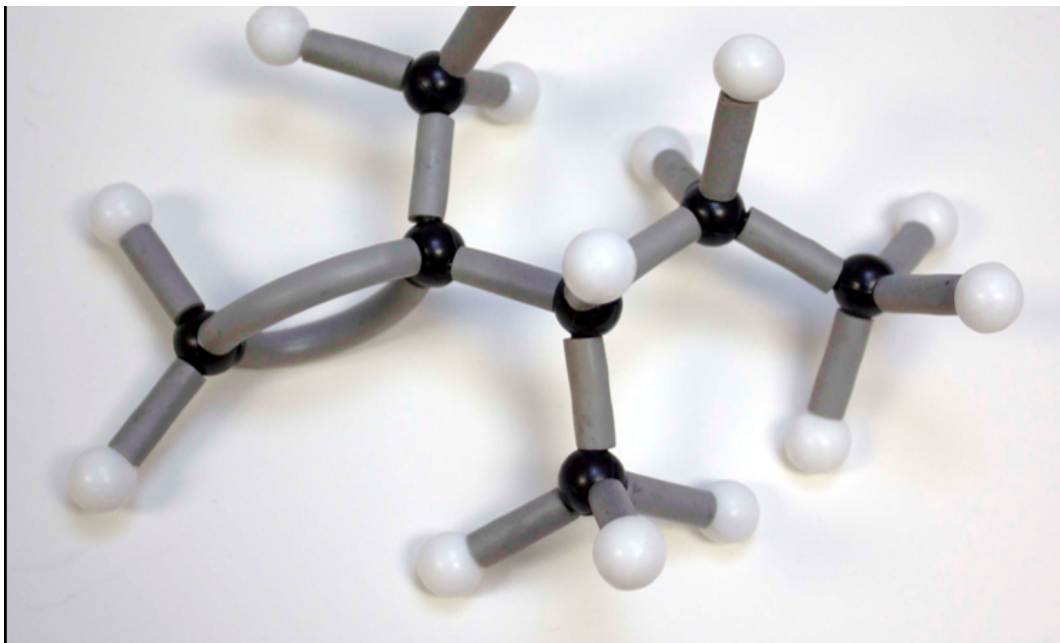
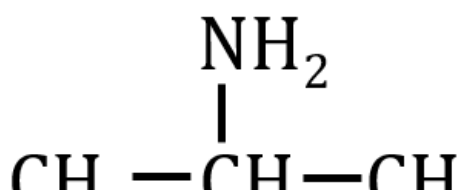


Photo 15: 2-propanamine - Structural Formula
(SAMPLE ANSWER BELOW)



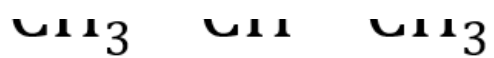


Photo 16: 2-propanamine – Molecular Model
(SAMPLE ANSWER BELOW)

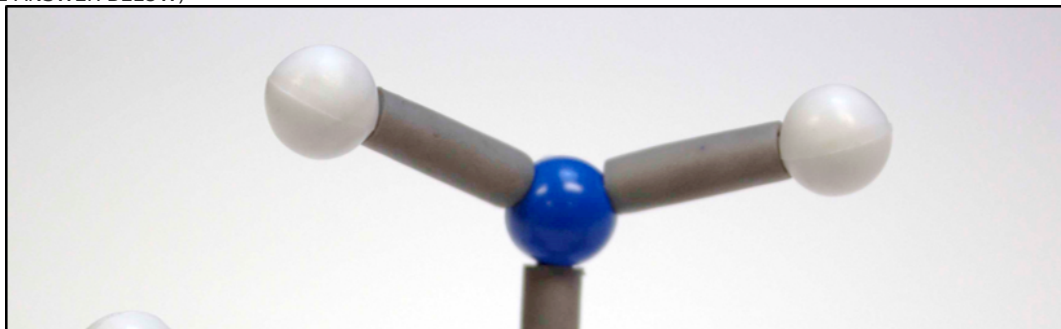




Photo 17: Ethanamide – Structural Formula
(SAMPLE ANSWER BELOW)



Photo 18: Ethanamide – Molecular Model
(SAMPLE ANSWER BELOW)



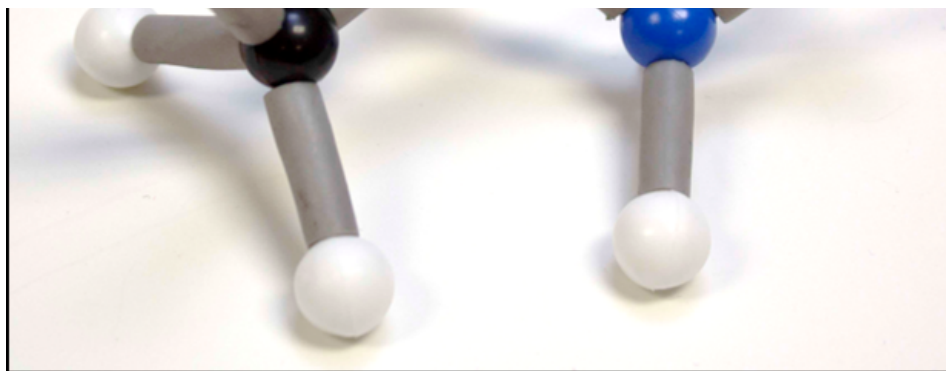


Photo 19: 4-ethyl-2-heptanol – Structural Formula
(SAMPLE ANSWER BELOW)

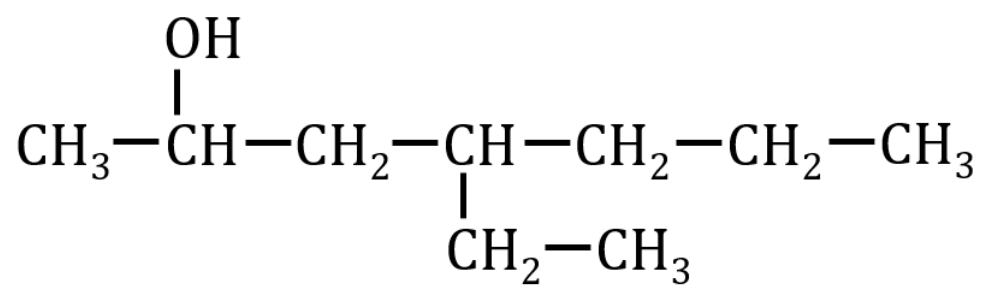


Photo 20: 4-ethyl-2-heptanol – Molecular Model
(SAMPLE ANSWER BELOW)

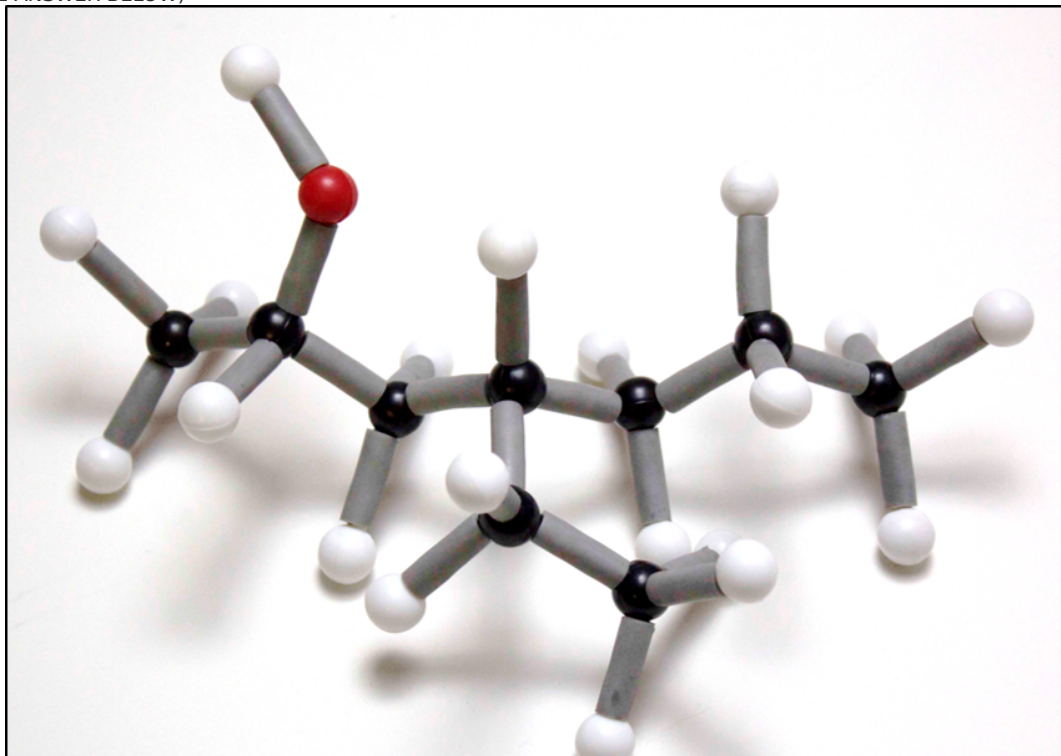




Photo 21: 3-methyl-2-octanone - Structural Formula
(SAMPLE ANSWER BELOW)

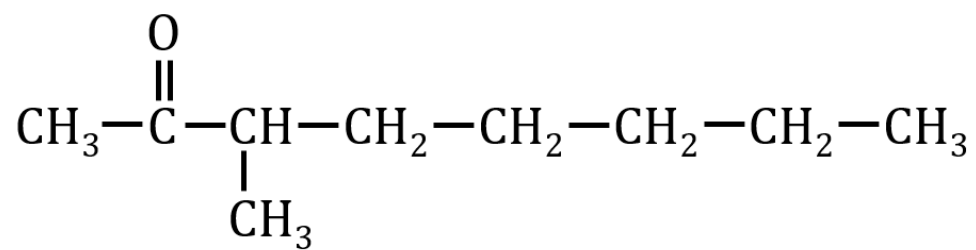
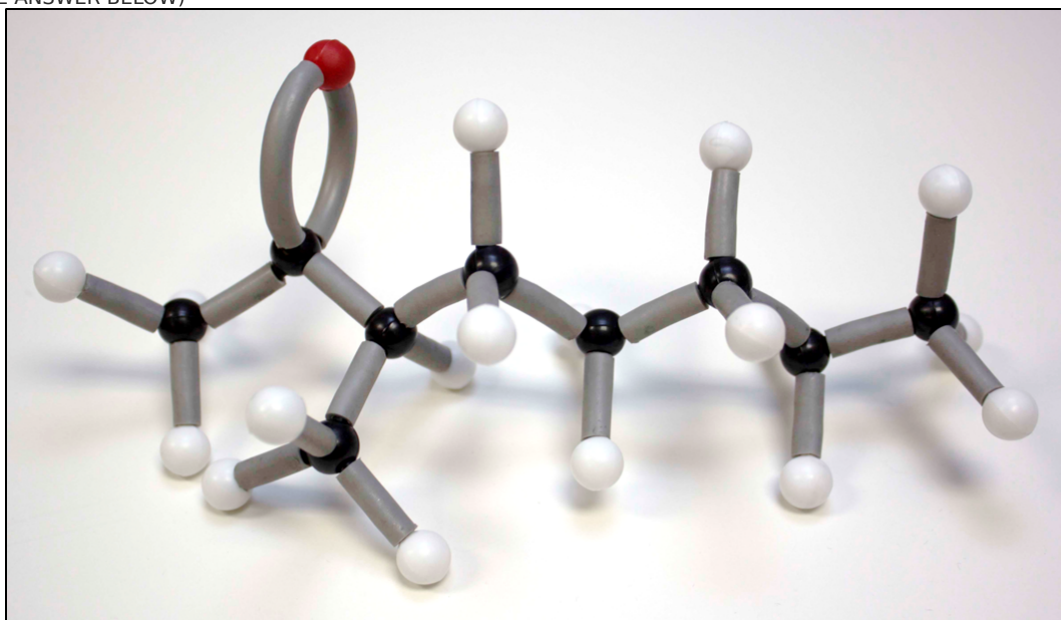


Photo 22: 3-methyl-2-octanone – Molecular Model
(SAMPLE ANSWER BELOW)



Competency Review

An ____ is the hydrocarbon family with a double bond between carbon atoms.

- ☐ alkyne
- ☐ amine
- ☐ alkane
- ☒ alkene ✓
- ☐ aldehyde

A(n) ____ is the functional group containing a carbonyl group and a nitrogen atom.

- ☐ amine
 - ☐ ester
 - ☒ amide ✓
 - ☐ carboxylic acid
 - ☐ ketone
-

The functional group containing an oxygen atom bonded between two R groups is known as a(n) ____.

- ☐ ester
 - ☐ carboxylic acid
 - ☒ ether ✓
 - ☐ ketone
 - ☐ aldehyde
-

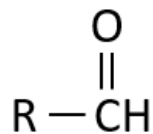
A(n) ____ is the functional group with a carbonyl group at the end of a carbon chain.

- ☐ ketone
 - ☐ carboxylic acid
 - ☐ ester
 - ☐ ether
 - ☒ aldehyde ✓
-

The functional group consisting of a carbonyl group bonded to a hydroxyl group is known as a(n) ____.

- ☐ ester
 - ☐ ketone
 - ☐ amide
 - ☒ carboxylic acid ✓
 - ☐ ether
-

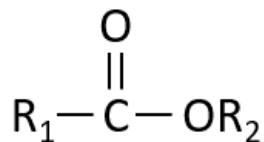
The possible name of a compound containing the functional group in the image below is ____.



- ☐ hexanamide
- ☒ ethanal
- ☐ methanol
- ☐ 3-pentanone
- ☐ propanoic acid
- ☐ methylbutanoate

✓

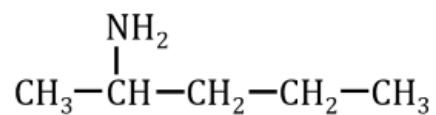
The possible name of a compound containing the functional group in the image below is ____.



- ☐ propanoic acid
- ☐ 3-pentanone
- ☐ ethanal
- ☐ hexanamide
- ☐ methanol
- ☒ methylbutanoate

✓

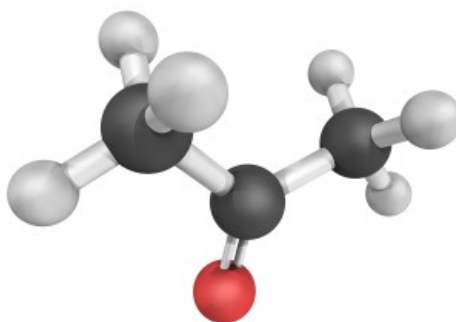
The name of the compound in the image below is ____.



- ☐ pentanoic acid
- ☐ butanamide
- ☐ pentanal
- ☒ 2-pentanamine

✓

The molecular model shown below has a(n) ____ functional group.



- ☐ amine
- ☐ ester
- ☒ ketone
- ☐ aldehyde

✓

The compound 1,2-dibromoethylheptanoate has a(n) ____ functional group.

- ☐ aldehyde
- ☐ ketone
- ☒ ester
- ☐ carboxylic acid

✓

Extension Questions

Use the internet to research the functional groups of aspirin, tylenol, and naproxen. Draw the structure of each compound on a sheet of paper, including your name and the date. Circle the functional groups on each compound and label them. Take a photo of the completed drawings and upload the image into the photo panel below. (SAMPLE ANSWER BELOW)

