Match the functional group with each of the correct compounds.

1. ether D
2. carboxylic acid E
3. alcohol C
4. amide A
5. ester B

6. Some aspirin substitutes contain phenacetin to reduce fever. Identify the functional groups in phenacetin.

a. Amide, aromatic, ether
b. Amine, aromatic, ester
c. Amine, carboxylic acid, ether
d. Aldehyde, ester, ketone
e. Aldehyde, aromatic, ether
7. Indicate whether the following represent stereoisomers, constitutional isomers, or are identical.

- stereoisomers
- constitutional isomers
- identical

Label the indicated atoms in the structure below as 1°, 2°, 3°, or 4°.

8. Carbon A is ________.
   a. 1°
   b. 2°
   c. 3°
   d. 4°

9. Carbon B is ________.
   a. 1°
   b. 2°
   c. 3°
   d. 4°

10. Carbon C is ________.
    a. 1°
    b. 2°
    c. 3°
    d. 4°
11. Name the following compounds

- (cis)-1,3-dimethylcyclohexane
- 4-isopropyl-2,3-dimethylheptane
- (cis) 1,2-dichloro-3-methylcyclopentane

12. Draw structures corresponding to each of the following names.

- trans-4-bromo-1-ethylcyclohexane
- (R)3-chloro-2,3,4-trimethylhexane


Consider the conformations of 2-methylbutane shown below to answer questions 14-16.

15. Which of the structures has two gauche interactions?
   D

16. Which of the structures represents the least stable conformation of 2-methylbutane?
   C

17. Which of the structures represents the most stable conformation of 2-methylbutane?
   A

Refer to the structure below to answer the questions 18-20:

18. Indicate all of the labeled atoms in the structure above that are axial bonds?
   G, H, B, D

19. Indicate all of the labeled bonds that are cis to atom A?
   H, G, E

20. Indicate all of the labeled bonds that have a 1,3-diaxial interaction with each other?
   G \& H
   B \& D
21. Calculate strain energy for the conformer pictured below.

\[ 3.8 \frac{kJ}{mol} \quad \text{or} \quad 0.9 \frac{kcal}{mol} \]

Use strain energy increments in Table to calculate the energy difference between the two chair conformations of the compound below, specify substituent positions (axial or equatorial) in the more stable chair, estimate the percent of the more stable chair at equilibrium at 25°C, and calculate \( K_{eq} \). HINT: Energy Difference = RT \( \ln K_{eq} \) where R=8.314 J/K.

22. The energy difference is \( 3.3 \) kJ/mol.

23. In the more stable chair the chloro group is in the \( \underline{\text{axial}} \) position.
   a. Axial
   b. equatorial

24. In the more stable chair the cyano group is in the \( \underline{\text{axial}} \) position.
   a. Axial
   b. equatorial

25. At 25°C what is the equilibrium percent of the more stable chair conformation?

\[ 31300 = RT \ln K \]
\[ 31300 = (8.314)(298) \ln K \]

\[ \ln K = 1.33 \]

\[ K_{eq} = \frac{3.788}{1} \quad \underline{79.1\%} \]
26. Assign R, S configurations to each chirality center in the molecules below and then classify the pair as enantiomers, diastereomers, or meso.

\[
\begin{align*}
\text{CHO} & \quad \text{CHO} \\
\text{HO} & \quad \text{H} \\
\text{H} & \quad \text{H} \\
\text{R} & \quad \text{S} \\
\text{R} & \quad \text{S} \\
\text{R} & \quad \text{R} \\
\text{R} & \quad \text{R} \\
\text{CH}_2\text{OH} & \quad \text{CH}_2\text{OH}
\end{align*}
\]

a. Enantiomers
b. Diastereomers
c. Meso

27. Assign R, S configurations to each chirality center in the molecules below and then classify the pair as enantiomers, diastereomers, or meso.

\[
\begin{align*}
\text{H}_3\text{C} & \quad \text{NH}_2 \\
\text{S} & \quad \text{S}_2 \text{CH}_3 \\
\text{OH} & \quad \text{H}
\end{align*}
\]

a. Enantiomers
b. Diastereomers
c. Meso

28. Place asterisks at all chirality carbons in the nucleotide drawn below.
29. A 1.750 g sample of unknown solution was dissolved in 10.0 mL of ethanol and placed in a sample cell with a 10.0 cm pathlength. The observed rotation at the sodium D line was +1.73°. Calculate \([\alpha]_D\) for the unknown.

\[
[\alpha]_D = \frac{\text{observed rotation}}{\text{pathlength, } l(\text{dm}) \times \text{Concentration (g/mL)}}
\]

\[
= \frac{1.73}{(1.0 \text{ dm})(\frac{1.750g}{10.0 mL})} = 9.89
\]

30. Draw a structural formula of the S configuration of the compound shown below. Illustrate the stereochemistry about the chiral carbon using the "single up" (solid wedge) and "single down" (hashed-line wedge) bond tools.

31. **Assign R,S configurations to each chirality center in the following molecules.** Which are enantiomers, which are meso, and which are diastereomers?

AB are ___ **enantiomers** ***diastereomers***
AD are ___ **meso**
BD are ___ **diastereomers**
AC are ___ **diastereomers**
BC are ___ **enantiomers**
CD are ___ **diastereomers**
Match the functional group with each of the correct compounds.

1. ether  
   ![Structure A](image)

2. carboxylic acid  
   ![Structure B](image)

3. alcohol  
   ![Structure C](image)

4. amide  
   ![Structure D](image)

5. ester  
   ![Structure E](image)

6. Some aspirin substitutes contain phenacetin to reduce fever. Identify the functional groups in phenacetin.

   ![Phenacetin](image)

   a. Amide, aromatic, ether
   b. Amine, aromatic, ester
   c. Amine, carboxylic acid, ether
   d. Aldehyde, ester, ketone
   e. Aldehyde, aromatic, ether
7. Indicate whether the following represent stereoisomers, constitutional isomers, or are identical.

\[ \text{structure} \]

- stereoisomers
- constitutional isomers
- identical

Label the indicated atoms in the structure below as 1°, 2°, 3°, or 4°.

\[ \text{structure} \]

8. Carbon A is ______.
   - a. 1°
   - b. 2°
   - c. 3°
   - d. 4°

9. Carbon B is ______.
   - a. 1°
   - b. 2°
   - c. 3°
   - d. 4°

10. Carbon C is ______.
    - a. 1°
    - b. 2°
    - c. 3°
    - d. 4°
11. Name the following compounds

12. Draw structures corresponding to each of the following names.

   trans-4-bromo-1-ethylcyclohexane
   (R)3-chloro-2,3,4-trimethylhexane


Consider the conformations of 2-methylbutane shown below to answer questions 14-16.

15. Which of the structures has two gauche interactions?

16. Which of the structures represents the least stable conformation of 2-methylbutane?

17. Which of the structures represents the most stable conformation of 2-methylbutane?

Refer to the structure below to answer the questions 18-20:

18. Indicate all of the labeled atoms in the structure above that are axial bonds?

19. Indicate all of the labeled bonds that are cis to atom A?

20. Indicate all of the labeled bonds that have a 1,3-diaxial interaction with each other?
21. Calculate strain energy for the conformer pictured below.

![Chemical structure](image)

Use strain energy increments in Table to calculate the energy difference between the two chair conformations of the compound below, specify substituent positions (axial or equatorial) in the more stable chair, estimate the percent of the more stable chair at equilibrium at 25°C, and calculate $K_{eq}$. HINT: Energy Difference = $RT \ln K_{eq}$ where $R=8.314 \text{ J/K}$. 

![Chemical structure](image)

22. The energy difference is \[ \text{kJ/mol} \].

23. In the more stable chair the **chloro** group is in the \[ \text{position} \].
   a. Axial
   b. equatorial

24. In the more stable chair the **cyano** group is in the \[ \text{position} \].
   a. Axial
   b. equatorial

25. At 25°C what is the equilibrium percent of the more stable chair conformation?
26. Assign R, S configurations to each chirality center in the molecules below and then classify the pair as enantiomers, diastereomers, or meso.

![Molecule 1](image1)

a. Enantiomers  
b. Diastereomers  
c. Meso

27. Assign R, S configurations to each chirality center in the molecules below and then classify the pair as enantiomers, diastereomers, or meso.

![Molecule 2](image2)

a. Enantiomers  
b. Diastereomers  
c. Meso

28. Place asterisks at all chirality carbons in the nucleotide drawn below.

![Nucleotide](image3)
29. A 1.750 g sample of unknown solution was dissolved in 10.0 mL of ethanol and placed in a sample cell with a 10.0 cm pathlength. The observed rotation at the sodium D line was +1.73°. Calculate \([\alpha]_D\) for the unknown.

\[
[\alpha]_D = \frac{\text{observed rotation}}{\text{pathlength, } l \text{ (dm)} \times \text{Concentration (g/mL)}}
\]

30. Draw a structural formula of the S configuration of the compound shown below. Illustrate the stereochemistry about the chiral carbon using the "single up" (solid wedge) and "single down" (hashed-line wedge) bond tools.

![Structural formula](image)

31. Assign R,S configurations to each chirality center in the following molecules. Which are enantiomers, which are meso, and which are diasteromers?

\[\text{A} \quad \text{B} \quad \text{C} \quad \text{D}\]

AB are ____________________
AD are ____________________
BD are ____________________
AC are ____________________
BC are ____________________
CD are ____________________