



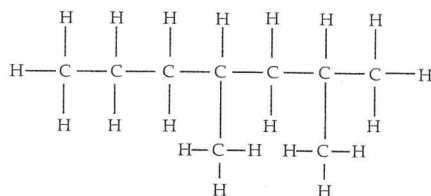
## Set 1. Nomenclature

1. Classify the following hydrocarbons as saturated or unsaturated and name them:

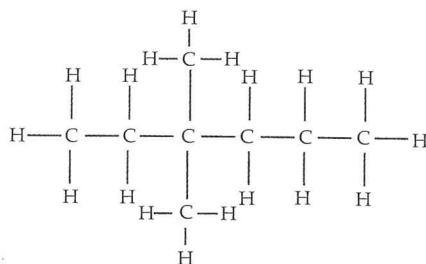
- (a)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$
- (b)  $\text{CH}_2\text{CHCH}_2\text{CH}_3$
- (c)  $\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}_3$
- (d)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{C}(\text{CH}_3)\text{C}(\text{CH}_3)\text{CH}_2\text{CH}_3$

2. Write condensed formulae for the following hydrocarbons and name them:

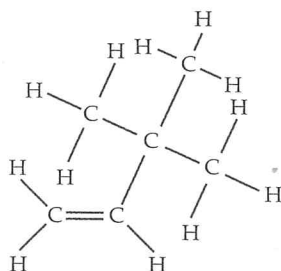
(a)



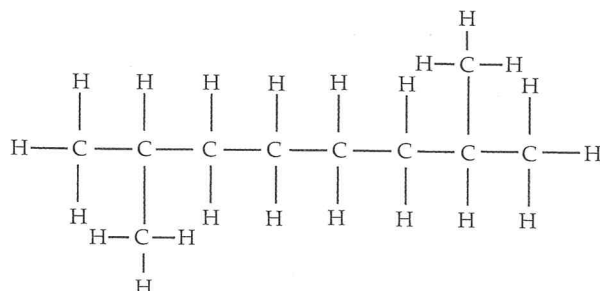
(b)



(c)

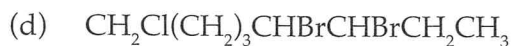


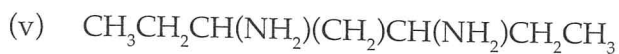
(d)



3. Draw structural formulae for the following hydrocarbons, showing all bonds and hydrogen atoms, and name them:
- (a)  $\text{CH}_3(\text{CH}_2)_2\text{CH}(\text{CH}_2\text{CH}_3)\text{CH}_2\text{CH}_3$
- (b)  $\text{CH}_3\text{CH}(\text{CH}_3)(\text{CH}_2)_3\text{CH}(\text{CH}_3)\text{CH}_3$
- (c)  $\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}(\text{CH}_3)\text{CH}_3$
- (d)  $\text{CH}_3(\text{CH}_2)_4\text{CH}(\text{CH}_3)\text{CH}_3$
4. Draw structural formulae for the following hydrocarbons and classify them as aliphatic, alicyclic or aromatic:
- (a) methylpropene
- (b) cyclopentene
- (c) 3-ethyl-2-methylheptane
- (d) 1,4-dimethylbenzene

5. Identify the functional group(s) in each of the following then name them using IUPAC conventions.





6. Write condensed structures for the following:

(a) butan-2-ol

(b) 2,3,3-triiodopentane

(c) propanal

(d) 3,3-dimethylhexan-2-ol

(e) butanoic acid

(f) pentylamine / 1-pentanamine

(g) 3-hydroxyheptanoic acid

(h) pentan-3-one

(i) 4-aminohexanoic acid

(j) butanamide

(k) 5,6-dichlorohepta-2,4-diene

(l) 4-oxo-pentanoic acid

7. Draw full structures for the following:

- (a) chlorocyclobutane
- (b) methylbenzene
- (c) *cis*-pent-2-ene
- (d) 1,2,4-triiodocyclohexene
- (e) methylpropanoate
- (f) 3-chlorobutanoic acid
- (g) 4,4-dimethylpentanal
- (h) 1,1,2-tribromopropene
- (i) 3-iodo-1-propanamine
- (j) butan-2-one
- (k) ethanedioic acid
- (l) pentane-1,2,4-triol
- (m) 1,3,5-triethylbenzene
- (n) 3-aminopropanoic acid
- (o) hexanamide



8. Name the following hydrocarbons from their line structures:

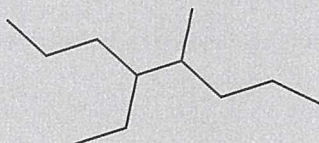
(a)



(b)



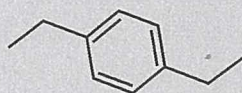
(c)



(d)



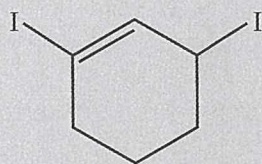
(e)



(f)



(g)



9. Draw line structures for the following:

(a) methylcyclopropane

(b) 1,3-diethylbenzene

(c) *trans*-3-hexene

(d) 1,2-cyclopentanediol

(e) ethylpentanoate



- (f) 2-hydroxypropanoic acid
- (g) 2,3-dibromopropanal
- (h) tetrachloroethene
- (i) ethylamine (ethanamine)
- (j) propanone
- (k) propanedioic acid
- (l) 1-penten-3-one
- (m) nitrobenzene
- (n) 3-ethyl-2,4-dimethylpentan-1-ol
- (o) propanamide
- (p) 1-chloro-3-methylbenzene
- (q) 2-aminopropanoic acid
- (r) butylbutanoate



## Set 2. Isomers

2. Draw structural formulae and name all isomers with the molecular formula  $C_5H_{10}$ .



3. Draw all of the isomers of trimethylbenzene.
4. Draw the following and determine which ones exhibit cis/trans isomerism.
- (a) pent-2-ene
  - (b) 1,1,2-trichlorobut-1-ene
  - (c) 2,4-dimethylhex-1-ene
  - (d) 1,2,3-tribromopropene
  - (e) buta-1,3-diene



## Set 3. Reactions and properties of the aliphatic hydrocarbons

### Combustion

1. (a) Using condensed structural formulae, write balanced equations for the complete combustion of the following:
  - i) butene  
\_\_\_\_\_
  - ii) methylpropane  
\_\_\_\_\_
- (b) Using condensed structural formulae, write balanced equations for the incomplete combustion of the following:
  - i) pentane  
\_\_\_\_\_
  - ii) cyclohexane  
\_\_\_\_\_

### Substitution

2. For each of the following reactions write balanced equations, using structural diagrams for all reactants and products. Name any organic products.
  - (a) chloromethane is produced by reacting methane and chlorine under UV light
  - (b)
    - (i) A limited supply of bromine and cyclobutane react in the presence of UV light
    - (ii) Excess bromine reacts with cyclobutane in UV light
  - (c) propane reacts with fluorine gas under UV light

**Addition**

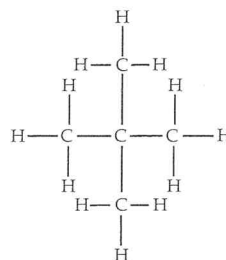
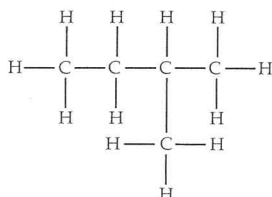
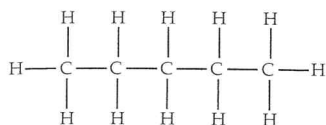
3. For each of the following reactions write balanced equations using structural diagrams for all reactants and products. Name any organic products.
- (a) the addition of hydrogen bromide to prop-1-ene
  
  
  
  
  
  
  
  
  
  
  - (b) the hydration of *cis*-but-2-ene using sulfuric acid as a catalyst
  
  
  
  
  
  
  
  
  
  
  - (c) the hydrogenation of *trans*-but-2-ene
  
  
  
  
  
  
  
  
  
  
  - (d) the chlorination of ethene

**Markovnikov's rule**

4. Name the predominant product when HCl is added to each of the following alkenes.
- (a)  $\text{CH}_3\text{CHCH}_2$
  
  
  
  
  
  - (b)  $\text{CH}_3(\text{CH}_3)\text{CCH}(\text{CH}_3)$
  
  
  
  
  
  - (c)  $\text{CHCCH}_2\text{CH}_3$



5. The isomers of pentane are shown below:



They have the same molar masses but their boiling points decrease from left to right. Explain with reference to the strength of intermolecular forces present in each.

6. Tetrachloroethene is used in dry cleaning and is an excellent solvent for organic substances but its solubility in water is low (0.150 g/L @25°C). Trichloroethene is a lot more soluble in water (1.23 g/L @25°C). Explain this difference in solubility with reference to the intermolecular forces present in each and also those that need to form for each to dissolve in water.



## Set 4. Reactions of the alicyclic and aromatic hydrocarbons

1. For each of the following reactions write equations, using line structural diagrams for all organic reactants and products. Name any organic products.
  - (a) cyclopentane and limited chlorine react under UV light
  
  
  
  
  
  
  
  
  
  
  - (b) bromine water is added to cyclohexene
  
2. Write equations for the production of the following compounds. Use line structural diagrams for all organic reactants and products.
  - (a) nitrobenzene
  
  
  
  
  
  
  
  
  
  
  - (b) propylbenzene
  
  
  
  
  
  
  
  
  
  
  - (c) cyclohexane
  
  
  
  
  
  
  
  
  
  
  - (d) chlorobenzene



## Set 5. Reactions and properties of alcohols

- Classify the following as primary, secondary or tertiary alcohols, and name them.
  - $\text{CH}_3\text{CH}_2\text{C}(\text{CH}_3)_2\text{OH}$   
\_\_\_\_\_
  - $\text{HOCH}_2\text{CH}_2\text{CH}_2\text{CH}_3$   
\_\_\_\_\_
  - $\text{CH}_3\text{CH}(\text{CH}_3)(\text{CH}_2)_3\text{CH}(\text{CH}_3)\text{OH}$   
\_\_\_\_\_
  - $\text{CH}_3\text{CH}_2\text{CHOHCH}_2\text{CH}_3$   
\_\_\_\_\_
- Butanol has four chain and positional isomers. Draw and name these.
- Write an equation for the complete combustion of propan-2-ol.
- Write an equation for the preparation of propan-2-ol. Use full structural formulae and name all reactants and products.



5. Write a balanced redox equation for the oxidation of butan-2-ol using acidified potassium dichromate. Name the products.

Reduction half equation	
Oxidation half equation	
Overall equation	
Names	

6. Write a balanced redox equation for the oxidation of pentan-1-ol using potassium permanganate. Name the products.

Reduction half equation	
Oxidation half equation	
Overall equation	
Names	

7. (a) Draw each of the following alcohols and list them in order of increasing boiling point.

butan-1-ol, ethanol, methyl propan-1-ol, methanol, methyl propan-2-ol

- (b) With reference to intermolecular bonding explain why you have placed them in this order.

8. Write a balanced equation for the reaction between sodium and propan-1-ol to produce sodium propoxide.

9. Describe how potassium dichromate could be used to determine whether an alcohol is secondary or tertiary. Include observations.

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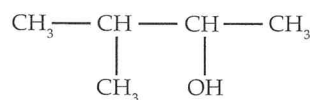
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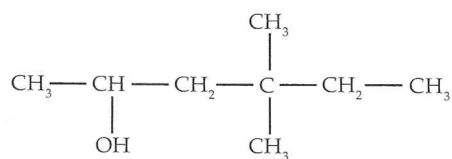
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10. Name the following alcohols:

(a)

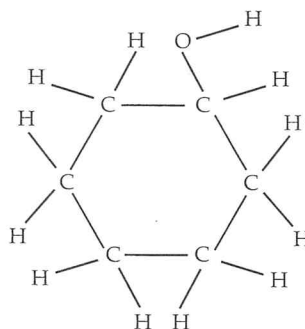


(b)



(c)  $\text{CH}_3\text{CH}(\text{CH}_3)\text{CHOHCH}_2\text{CH}_3$

(d)





## Set 6. Aldehydes, ketones, carboxylic acids and esters

1. Identify the following as aldehydes, ketones, carboxylic acids or esters:

- (a)  $\text{CH}_3\text{COCH}_2\text{CH}_3$  \_\_\_\_\_
- (b)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOCH}_2\text{CH}_2\text{CH}_3$  \_\_\_\_\_
- (c)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CHO}$  \_\_\_\_\_
- (d)  $\text{CH}_3(\text{CH}_2)_4\text{COOH}$  \_\_\_\_\_
- (e)  $\text{CH}_3(\text{CH}_2)_5\text{COCH}_3$  \_\_\_\_\_
- (f)  $\text{CH}_3\text{CH}_2\text{OOCCH}_2\text{CH}_3$  \_\_\_\_\_
- (g)  $\text{CH}_3\text{COCH}_2\text{CH}_2\text{CH}_2\text{COOH}$  \_\_\_\_\_

2. Name each of the compounds in Q1 above.

- (a) \_\_\_\_\_
- (b) \_\_\_\_\_
- (c) \_\_\_\_\_
- (d) \_\_\_\_\_
- (e) \_\_\_\_\_
- (f) \_\_\_\_\_
- (g) \_\_\_\_\_

3. Write an equation for the complete combustion of propanone.

4. Write an equation for the incomplete combustion of butanoic acid (in limited  $\text{O}_2$ ).



5. Write a balanced redox equation for the oxidation reaction which producing butanal using acidified potassium permanganate.

Reduction half equation	
Oxidation half equation	
Overall equation	
Names of all species	

6. Write a balanced redox equation for the oxidation produces pentan-3-one using acidified potassium dichromate.

Reduction half equation	
Oxidation half equation	
Overall equation	
Names of all species	

7. Name the starting materials required to produce butanoic acid in the laboratory.

8. Write an equation for the production of propyl butanoate in the laboratory.

9. Write a balanced equation for the reaction between propanoic acid and the following substances. Give full observations.

(a) magnesium carbonate

equation:

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observations:

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(b) sodium

equation:

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observations:

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(c) potassium hydroxide

equation:

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observations:

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(d) ethanol and concentrated sulfuric acid

equation:

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observations:

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(e) acidified potassium dichromate

equation:

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observations:

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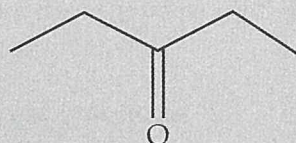
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10. The following compounds are all of similar molecular mass. Place them in order of increasing boiling point and explain your logic, with reference to their shapes and the intermolecular forces present in each.

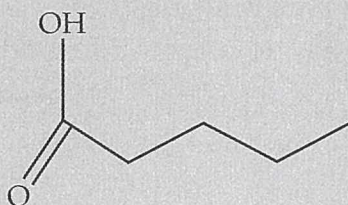
1-butanol, butanoic acid, butanal, butane

11. Match each line structure to its major functional group with arrows.

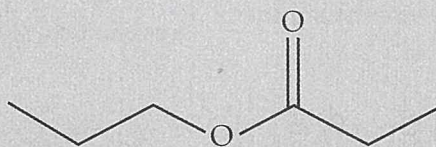
ester



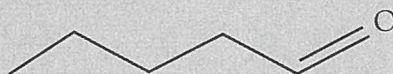
aldehyde



ketone



carboxylic acid



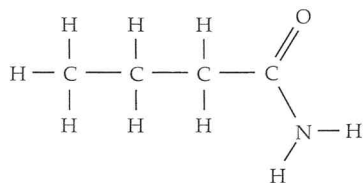


**Set 7. Amines, amides and amino acids**

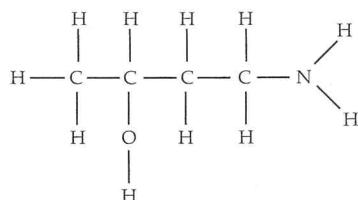
1. Identify the following as amines, amides or amino acids and name them:
  - (a)  $\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_2\text{CONH}_2$
  - (b)  $\text{CH}_3\text{CH}(\text{NH}_2)\text{CH}_2\text{CH}_3$
  - (c)  $\text{H}_2\text{NCH}_2(\text{CH}_2)_6\text{CH}_3$
  - (d)  $\text{CH}_3\text{CHNH}_2\text{COOH}$
  - (e)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CONH}_2$
  - (f)  $\text{H}_2\text{NCH}_2\text{CH}_2\text{COOH}$
2. Classify the following as primary, secondary or tertiary amines and draw them using full structural formulae.
  - (a)  $\text{H}_3\text{CNH}_2$
  - (b)  $\text{CH}_3\text{CH}_2\text{N}(\text{CH}_3)_2$
  - (c)  $\text{H}_2\text{NCH}(\text{CH}_3)_2$
  - (d)  $\text{H}_3\text{CN}(\text{CH}_3)_2$
  - (e)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{NHCH}_3$

3. Name the following:

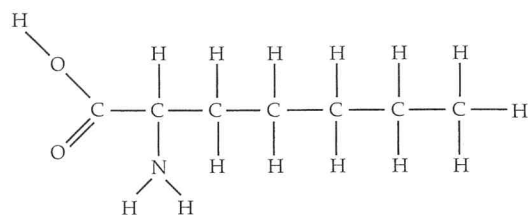
(a)



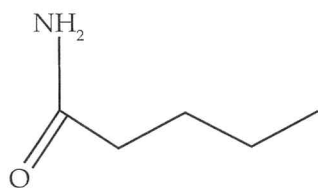
(b)



(c)



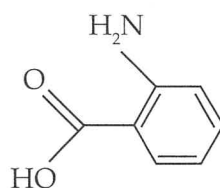
(d)



(e)



(f)



4. Prepare full structural formulae for the following:

(a) ethyldimethylamine

(b) propanamide

(c) 3-aminobutanoic acid

(d) 3-methylpentan-2-amine

(e) 3-aminopentanoic acid

5. Which of the following are  $\alpha$ -amino acids? (You may need to sketch them).

(a)  $\text{H}_3\text{CC}(\text{CH}_3)(\text{NH}_2)\text{COOH}$

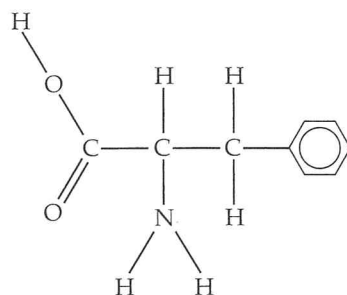
(b)  $\text{H}_3\text{CCH}(\text{NH}_2)\text{COOH}$

(c)  $\text{H}_3\text{CCH}(\text{NH}_2)\text{CH}_2\text{COOH}$

(d)  $\text{H}_3\text{CC}(\text{CH}_3)(\text{NH}_2)\text{CH}_2\text{CH}_2\text{COOH}$

(e)  $\text{HOOCCH}(\text{NH}_2)\text{CH}_3$

6. Phenylalanine is an amino acid shown below:



- (a) Draw phenylalanine in its zwitterionic form under neutral conditions.

- (b) Draw phenylalanine when in acidic conditions.

- (c) Draw phenylalanine when in alkaline conditions.