



Give the marks for the points in the marking scheme; an answer in other words that says the same is right.

1 Key words

1. organic compounds
2. hydrocarbons
3. saturated
4. paraffins
5. unsaturated
6. homologous series
7. functional group
8. hydrogenation

K • 4

Each carries 0.5 mark.

2 Label the diagram

- | | | |
|---|--|-------|
| 1. methanol methyl alcohol, CH_3OH • monohydric | 3. ethanol ethyl alcohol, $\text{C}_2\text{H}_5\text{OH}$ • monohydric | K • 2 |
| 2. ethane-1,2-diol glycol, $\text{C}_2\text{H}_4(\text{OH})_2$ • dihydric | 4. propane-1,2,3-triol glycerol, $\text{C}_3\text{H}_5(\text{OH})_3$ • trihydric | |

Each carries 0.5 mark.

3 Multiple choice

- i. a. methane K • 1
Methane, CH_4 , has only single bonds. Ethene is an alkene; acetylene (ethyne) and propyne are alkynes.
- ii. d. $\text{C}_3\text{H}_5(\text{OH})_3$ K • 1
Glycerol is propane (C_3H_8) with three H replaced by three OH: $\text{C}_3\text{H}_5(\text{OH})_3$. (The others either don't have three OH groups or don't give carbon four bonds.)
- iii. c. propane U • 1
Glycerol, propane-1,2,3-triol, is propane with three -OH groups. (Glucose isn't a hydrocarbon at all.)
- iv. c. calcium carbonate, CaCO_3 U • 1
Carbonates (like limestone and marble), carbon dioxide, carbon monoxide, hydrogencarbonates and carbides are counted as inorganic. Urea was the first organic compound made from an inorganic one.
- v. c. alkyne A • 1
For $n = 6$: an alkane would be C_6H_{14} ($2n + 2$), an alkene C_6H_{12} ($2n$), an alkyne C_6H_{10} ($2n - 2$). So it is an alkyne: hexyne.

4 Very short answers

- a. MARKING SCHEME K • 1
✓ $\text{C}_n\text{H}_{2n-2}$
- b. MARKING SCHEME K • 1
✓ Methane (CH_4).
- c. MARKING SCHEME A • 1
✓ Propene.



5 Short answers

a. MARKING SCHEME

U • 2

- ✓ In ethane the two carbon atoms are joined by a single covalent bond.
- ✓ Each carbon's other bonds are all taken by hydrogen, so it holds as much hydrogen as it can and no more atoms can be added.

b. MARKING SCHEME

U • 2

- ✓ A glycerol molecule, $C_3H_5(OH)_3$, has three hydroxyl ($-OH$) groups, one on each carbon.
- ✓ An alcohol with three $-OH$ groups is called trihydric.

c. MARKING SCHEME

U • 2

- ✓ Any one difference, e.g. a monohydric alcohol has one $-OH$ group in each molecule; a dihydric alcohol has two.
- ✓ Any second difference, e.g. general formula $C_nH_{2n+1}OH$ against $C_nH_{2n}(OH)_2$, or the examples ethanol (C_2H_5OH) against glycol ($C_2H_4(OH)_2$).

d. MARKING SCHEME

K • 2

- ✓ i. Methyl alcohol (methanol) and (ii) ethyl alcohol (ethanol).
- ✓ iii. Ethyl alcohol and (iv) ethyl alcohol (ethanol).

6 Long answers

a. ANSWER

U • 4

Alcohols are organic compounds formed when one or more hydrogen atoms of an alkane are replaced by hydroxyl ($-OH$) groups. Their functional group is $-OH$.

- **Monohydric** (one $-OH$): methanol, CH_3OH ; ethanol, C_2H_5OH .
- **Dihydric** (two $-OH$): glycol (ethane-1,2-diol), $C_2H_4(OH)_2$.
- **Trihydric** (three $-OH$): glycerol (propane-1,2,3-triol), $C_3H_5(OH)_3$.

Structural formulas: as in the figure in the book. Ethanol, for example, is H_3C-CH_2-OH drawn out with every bond: two carbons in a row, three H on the first, two H on the second, and the $-OH$ at the end.

MARKING SCHEME

- ✓ Alcohols: compounds formed when one or more H atoms of an alkane are replaced by $-OH$ (hydroxyl) groups.
- ✓ Monohydric (one $-OH$), e.g. methanol CH_3OH or ethanol C_2H_5OH .
- ✓ Dihydric (two $-OH$), e.g. glycol $C_2H_4(OH)_2$; trihydric (three $-OH$), e.g. glycerol $C_3H_5(OH)_3$.
- ✓ A correct structural formula of one alcohol of each kind drawn (or of the examples named).



b. ANSWER

A · 4

Glycerol (glycerine), $C_3H_5(OH)_3$. IUPAC name: **propane-1,2,3-triol**. Structural formula: three carbons in a row, with one $-OH$ on each, as in the figure in the book.

Uses:

1. in creams and lotions, to keep the skin moist;
2. in good-quality soaps, cosmetics and shaving creams;
3. as a sweetener in foods, and to keep dried fruit and tobacco moist.

MARKING SCHEME

- ✓ Glycerol (glycerine), $C_3H_5(OH)_3$.
- ✓ IUPAC name: propane-1,2,3-triol.
- ✓ Structural formula: three carbons in a chain, one $-OH$ on each, every C with four bonds.
- ✓ Three uses, e.g. skin creams (keeps skin moist), soaps and cosmetics, sweetener in food.

7 Numerical problems

a. ANSWER

A · 2

C_nH_{2n+2} with $n = 7$: $H = 2 \times 7 + 2 = 16$, so C_7H_{16} (heptane). Mass = $7 \times 12 + 16 \times 1 = 84 + 16 = 100$.

MARKING SCHEME

- ✓ C_7H_{16} (from C_nH_{2n+2}).
- ✓ Molecular mass = $7 \times 12 + 16 \times 1 = 100$.

b. ANSWER

A · 2

An alkene is C_nH_{2n} , so its mass is $12n + 2n = 14n$. $14n = 56$, so $n = 4$: C_4H_8 , butene. (Check: $4 \times 12 + 8 = 56$.)

MARKING SCHEME

- ✓ Mass of $C_nH_{2n} = 14n = 56$, so $n = 4$.
- ✓ C_4H_8 , butene.

8 Think

ANSWER

HA · 2

The oil is heated with hydrogen gas and a nickel catalyst: hydrogenation. Liquid oils contain unsaturated fatty acids, whose $C=C$ double bonds bend them so they can't pack together. Hydrogen adds across the double bonds and makes them saturated: straight chains that pack closely, so the fat is solid.

MARKING SCHEME

- ✓ Hydrogenation: the oil is heated with hydrogen and a nickel catalyst, and hydrogen adds across its $C=C$ double bonds.
- ✓ The unsaturated (bent) fatty acids become saturated (straight) ones, which pack together into a solid fat.

9 Activity: Models of hydrocarbons

(not marked)

WHAT STUDENTS SHOULD FIND

Methane: 1 carbon, 4 hydrogens, no $C-C$ bond; its hydrogens point to the corners of a tetrahedron (3-D). Ethane: 2 carbons, 6 hydrogens, a single bond; 3-D. Ethene: 2 carbons, 4 hydrogens, a double bond; flat. Ethyne: 2 carbons, 2 hydrogens, a triple bond; a straight line. Every carbon has four toothpicks however they are shared, which is why each extra bond between the carbons leaves room for two fewer hydrogens.

Marks by level	Knowledge	Understanding	Application	Higher ability	Total
Marks	12	12	10	2	36

