Review topic: Organic chemistry

Ways to practice skills		R	A	G	Comment
11.1 Formulae, functional groups and terminology					CH_3CH_2OH → C_2H_6O structural formula
1	Draw and interpret the displayed formula of a molecule to show all the atoms and all the bonds	☐	☐	☐	
2	Write and interpret general formulae of compounds in the same homologous series, limited to: a. alkanes, C_nH_{2n+2} $n \geq 1$ b. alkenes, C_nH_{2n} $(n \geq 2)$ c. alcohols, $C_nH_{2n+1}OH$ $n \geq 1$ d. carboxylic acids, $C_nH_{2n+1}COOH$ $n \geq 0$	☐	☐	☐	
3	Identify a functional group as an atom or group of atoms that determine the chemical properties of a homologous series	☐	☐	☐	homologous series ⇓ functional group ⇓ similar chemical properties
4	State that a homologous series is a family of similar compounds with similar chemical properties due to the presence of the same functional group	☐	☐	☐	$HOCOCH_2CH_3$ HOC_2H_5
5	State that a saturated compound has molecules in which all carbon–carbon bonds are single bonds	☐	☐	☐	
6	State that an unsaturated compound has molecules in which one or more carbon–carbon bonds are not single bonds	☐	☐	☐	
7	State that a structural formula is an unambiguous description of the way the atoms in a molecule are arranged, including $CH_2{=}CH_2$, CH_3CH_2OH, CH_3COOCH_3	☐	☐	☐	
8	Define structural isomers as compounds with the same molecular formula, but different structural formulae, including C_4H_{10} as $CH_3CH_2CH_2CH_3$ and $CH_3CH(CH_3)CH_3$ and C_4H_8 as $CH_3CH_2CH{=}CH_2$ and $CH_3CH{=}CHCH_3$ → but-2-ene	☐	☐	☐	$CH_3CH(CH_3)CH_3$ 2-methylpropane; $CH_3CH_2CH_2CH_3$ butane; but-1-ene; methylpropane
☆ 9	Describe the general characteristics of a homologous series as: a. having the same functional group to share similar chemical properties b. having the same general formula c. differing from one member to the next by a $-CH_2-$ unit d. displaying a trend in physical properties ~~e. sharing similar chemical properties~~	☐	☐	☐	cyclobutane
11.2 Naming organic compounds					methane natural gas; ethane; 结构↑ bp↑
1	Name and draw the displayed formulae of: a. methane and ethane b. ethene c. ethanol d. ethanoic acid e. the products of the reactions stated in sections 11.4–11.7	☐	☐	☐	Alkene: C_4H_8 $CH_3CH_2CH{=}CH_2$ but-1-ene $CH_3CH{=}CHCH_3$ → but-2-ene 2-methylpropene methylpropene

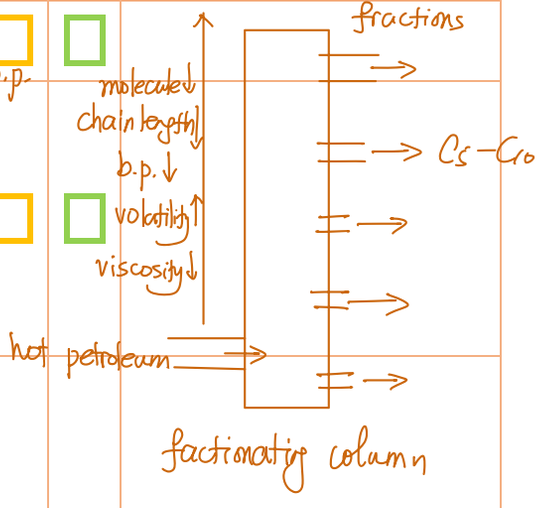
Alcohol: C_2H_5OH CH_3CH_2OH ethanol; C_3H_7OH $CH_3CH_2CH_2OH$ propan-1-ol; $CH_3CH(OH)CH_3$ propan-2-ol

Carboxylic acid
$HCOOH$: methanoic acid
CH_3COOH: ethanoic acid

C_4H_9OH $CH_3CH_2CH_2CH_2OH$ butan-1-ol $CH_3CH_2CH(OH)CH_3$ butan-2-ol $CH_3CH(CH_3)CH_2OH$ 2-methylpropan-1-ol $CH_3C(CH_3)(OH)CH_3$ 2-methylpropan-2-ol

CH_3CH_2COOH : propanoic acid $CH_3CH_2CH_2COOH$: butanoic acid

$CH_3CH(CH_3)COOH$: 2-methylpropanoic acid (相同) methylpropanoic acid

2	State the type of compound present, given a chemical name ending in -ane, -ene, -ol, or -oic acid or from a molecular formula or displayed formula				
3	Name and draw the structural and displayed formulae of unbranched: a. alkanes b. alkenes, including but-1-ene and but-2-ene c. alcohols, including propan-1-ol, propan-2-ol, butan-1-ol and butan-2-ol d. carboxylic acids containing up to four carbon atoms per molecule				
4	Name and draw the displayed formulae of the unbranched esters which can be made from unbranched alcohols and carboxylic acids, each containing up to four carbon atoms				
11.3 Fuels					
1	Name the fossil fuels: coal (s), natural gas (g) and petroleum (l)				
2	Name methane as the main constituent of natural gas				
3	State that hydrocarbons are compounds that contain hydrogen and carbon only				
4	State that petroleum is a mixture of hydrocarbons				
5	Describe the separation of petroleum into useful fractions by fractional distillation → small difference in b.p.				
6	Describe how the properties of fractions obtained from petroleum change from the bottom to the top of the fractionating column, limited to: e. decreasingchainlength f. higher volatility g. lower boiling points h. lower viscosity				
☆ 7	Name the uses of the fractions as: a. refinery gas fraction for gas used in heating and cooking b. gasoline / petrol fraction for fuel used in cars (C_5-C_{10}) c. naphtha fraction as a chemical feedstock d. kerosene / paraffin fraction for jet fuel e. diesel oil / gas oil fraction for fuel used in diesel engines f. fuel oil fraction for fuel used in ships and home heating systems g. lubricating oil fraction for lubricants, waxes and polishes h. bitumen fraction for making roads				cracking: large alkane → small alkane (gasoline) + small alkene (raw material) catalytic cracking: catalyst: zeolite / SiO_2 / Al_2O_3
11.4 Alkanes					
1	State that the bonding in alkanes is single covalent and that alkanes are saturated hydrocarbons				

2	Describe the properties of alkanes as being generally unreactive, except in terms of combustion and substitution by chlorine				
☆ 3	State that in a substitution reaction one atom or group of atoms is replaced by another atom or group of atoms				$CH_4 + Cl_2 \xrightarrow{\text{sunlight / UV light}} CH_3Cl + HCl$ (chloromethane) $CH_4(g) + Br_2(aq) \xrightarrow[\text{orange}]{\text{sunlight}} CH_3Br + HBr$ (bromomethane)
4	Describe the substitution reaction of alkanes with chlorine as a photochemical reaction, with ultraviolet light providing the activation energy, E_a, and draw the structural or displayed formulae of the products, limited to monosubstitution				Observation: orange → colorless / fade / decolorized
11.5 Alkenes					Addition.
1	State that the bonding in alkenes includes a double carbon–carbon covalent bond and that alkenes are unsaturated hydrocarbons				
2	Describe the manufacture of alkenes and hydrogen by the cracking of larger alkane molecules using a high temperature and a catalyst				
3	Describe the reasons for the cracking of larger alkane molecules				
4	Describe the test to distinguish between saturated and unsaturated hydrocarbons by their reaction with aqueous bromine				$C_2H_4 + Br_2 \rightarrow C_2H_4Br_2$ 1,2-dibromoethane ✓ 1,1-dibromoethane ✗ Observation: decolorized
5	State that in an addition reaction only one product is formed				
6	Describe the properties of alkenes in terms of addition reactions with: a. bromine or aqueous bromine ✓ b. hydrogen in the presence of a nickel catalyst c. steam in the presence of an acid catalyst and draw the structural or displayed formulae of the products				$C_2H_4 + H_2 \xrightarrow[300°C]{Ni} C_2H_6$ $C_2H_4 + H_2O \xrightarrow{\text{conc. } H_3PO_4} C_2H_5OH$ (steam)
11.6 Alcohols					$C_3H_6 + H_2O \rightarrow C_3H_7OH$ propan-1-ol or propan-2-ol $CH_2=CHCH_3 + H_2O \rightarrow$ H加在H多的C上.
1	Describe the manufacture of ethanol by: a. fermentation of aqueous glucose at 25–35 °C in the presence of yeast and in the absence of oxygen b. catalytic addition of steam to ethene at 300 °C and 6000 kPa / 60 atm in the presence of an acid catalyst (H_3PO_4)				$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$ conditions: without oxygen, 25–35°C, yeast → catalyst (enzyme) $C_2H_4 + H_2O \rightarrow C_2H_5OH$ → 工业 → solvent
2	Describe the combustion of ethanol				
3	State the uses of ethanol as: a. a solvent b. afuel				
4	Describe the advantages and disadvantages of the manufacture of ethanol by: a. fermentation b. catalytic addition of steam to ethene				

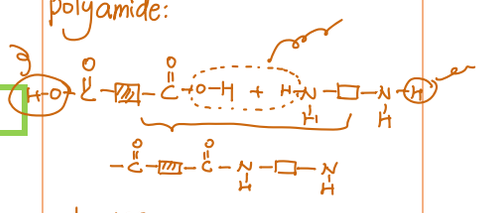
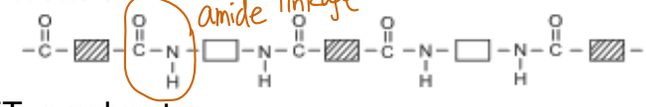
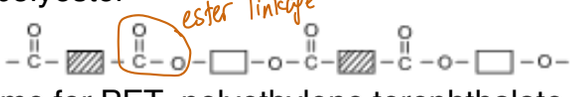
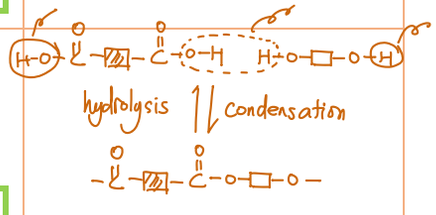
$HNO_2 + NaOH \rightarrow NaNO_2 + H_2O$
nitric acid — Sodium nitrite

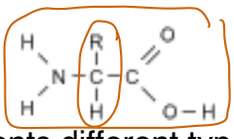
ethanoic acid — Sodium ethanoate $NaCH_3COO$

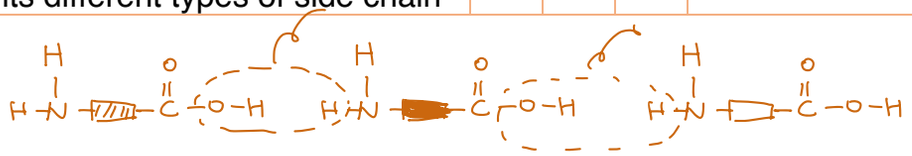
$CH_3COOH + NaOH \longrightarrow CH_3COONa + H_2O$

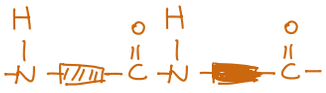
$HCOOH + Mg \longrightarrow Mg(HCOO)_2 + H_2$ (magnesium methanoate)

$2CH_3CH_2COOH + Na_2CO_3 \longrightarrow 2CH_3CH_2COONa + H_2O + CO_2$ (sodium propanoate)

11.7 Carboxylic acids					
1	Describe the reactions of carboxylic acids with: a. metals b. bases c. carbonates including names and formulae of the salts produced				
2	Describe the formation of ethanoic acid by the oxidation of ethanol: a. with acidified (H_2SO_4) aqueous potassium manganate(VII) → purple to colorless b. by bacterial oxidation during vinegar production				Alcohol → (oxidation) Carboxylic acid
3	Describe the reaction of a carboxylic acid with an alcohol using an acid catalyst to form an ester				
11.8 Polymers					Esterification / Condensation: $CH_3CH_2COOH + CH_3OH \xrightarrow{H_2SO_4} CH_3CH_2COOCH_3 + H_2O$ (methyl ethanoate)
1	Define polymers as large molecules built up from many smaller molecules called monomers				
2	Describe the formation of poly(ethene) as an example of addition polymerisation using ethene monomers				Alkene → addition polymer; $n(CH_2=CH_2) \longrightarrow -(CH_2-CH_2)_n-$ (monomer; plastic; non-bio-degradable); poly(ethene)
3	State that plastics are made from polymers				$n(CH_2=CHCH_3) \longrightarrow -(CH_2CH(CH_3))_n-$ ✓ poly(propene); ✗
4	Describe how the properties of plastics have implications for their disposal				
5	Describe the environmental challenges caused by plastics, limited to: a. disposal in land fill sites b. accumulation in oceans c. formation of toxic gases from burning				
6	Identify the repeat units and / or linkages in addition polymers and in condensation polymers				
7	Deduce the structure or repeat unit of an addition polymer from a given alkene and vice versa				
8	Deduce the structure or repeat unit of a condensation polymer from given monomers and vice versa, limited to: a. polyamides from a dicarboxylic acid and a diamine b. polyesters from a dicarboxylic acid and a diol				polyamide:  polyester
9	Describe the differences between addition and condensation polymerisation				
10	Describe and draw the structure of a. nylon, a polyamide  (amide linkage) b. PET, a polyester  (ester linkage) The full name for PET, polyethylene terephthalate, is not required.				PET  (hydrolysis // condensation)

11	State that PET can be converted back into monomers and re-polymerised				
12	Describe proteins as natural polyamides and are formed from amino acid monomers with the general structure  , where R represents different types of side chain				



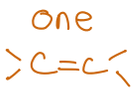


Summary:

Addition polymer

monomer

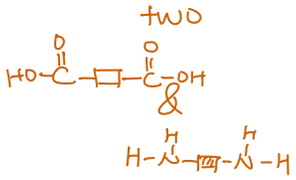
one



Condensation polymer

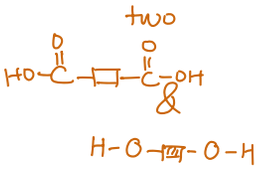
polyamide

two



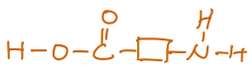
polyester

two



protein

many



type: Addition

products: ⟶ polymer

Condensation

⟶ polymer + H_2O