PL.a-t - Polymers and life | PL1-9 |

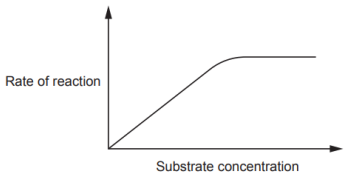
PL.Q Exam questions from past papers

State the meaning of the symbols used in the mechanism and explain how this mechanism accounts for the shape of the curve in fig 35.2?

Enzymes are proteins that catalyse certain reactions. They can be used by viruses to infect cells.

The rates of enzyme-catalysed reactions typically vary with substrate concentration as shown in the graph in **Fig. 35.2**.

Fig. 35.2



The mechanism of an enzyme-catalysed reaction can be written:

$E + S \rightarrow ES \rightarrow EP \rightarrow E + P$

State the meaning of the symbols used in the mechanism and explain how this mechanism accounts for the shape of the curve in **Fig. 35.2**. **[6]**

- E is enzyme, S is substrate, ES is enzyme-substrate complex, EP is enzyme-product complex, P is product

Low [S]

- When [S] is low there are enough active sites for E to bind to all of S -> rate increases as [S] increases
- Rate is proportional to [S]
- Reaction is 1st Order w.r.t [S]
- RDS is E+S->ES

High [S]

- When [S] is high all active sites are occupied -> no change in rate
- Increasing [S] has no effect on rate
- Reaction is zero order w.r.t [S]
- RDS is EP -> E+P (or ES->EP)

Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.

Level 3 (5–6 marks)
A good knowledge of mechanism with good evaluation of shape of curve including consideration of both RDS **AND** order of reaction for both high and low [S].

There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.

Level 2 (3–4 marks)
A good knowledge of mechanism with evaluation of shape of curve including some consideration of RDS / order of reaction for high / low [S] ,/ change in shape of graph

There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.

Level 1 (1–2 marks)
Most of the symbols are explained
Simple description of rate

There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.

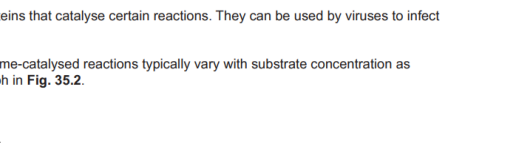
0 marks
No response or no response worthy of credit.

6	2.7 (x3) 3.2 (x3)	***Indicative scientific points include*** **Knowledge of mechanism** • E is enzyme • S is substrate • ES is the enzyme-substrate complex. • EP is the enzyme-product complex. • P is the product **Evaluation of shape of curve** *low [S]:* • When [S] is low, sufficient active sites on E for all S to bind, rate increases as [S] increases • Rate is proportional to [S] • Reaction is first order (wrt [S]). • RDS is E + S → ES *high [S]* • When [S] is high, all active sites are occupied, no change in rate • Increasing [S] has no effect on rate • Reaction is zero order wrt [S] • RDS is EP → E + P (or ES → EP)

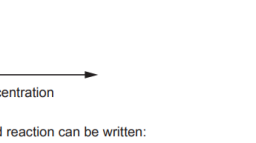
Draw a ring around the pharmacophore on the structure of 'Imatinib' above?

5 'Imatinib' is a drug that was designed to combat leukaemia, a cancer of the blood. 'Imatinib' was developed as a result of work on three different compounds (**A**, **B** and **C**).

Compound **A** was found to have anti-leukaemia effects. Compound **B** was then found to be more effective and compound **C** more specific. 'Imatinib' was developed from compound **C**.



Compound A **Compound B** **Compound C**

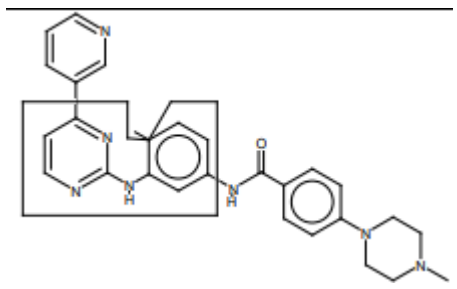


'Imatinib'

(b) 'Imatinib' works by interfering with the function of an enzyme that only exists in cells affected by leukaemia. Thus the cells are unable to grow.

(i) All the compounds above have the same pharmacophore.

Draw a ring around the pharmacophore on the structure of 'Imatinib' above. **[1]**



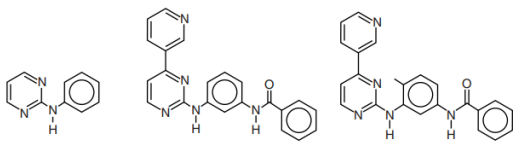
ALLOW lines cutting bonds to do so anywhere on the bond.

Suggest how this pharmacophore (Compound A) interferes with the function of the enzyme? [3]

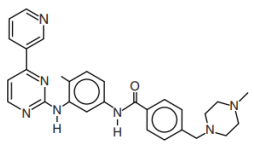
(ii) Suggest how this pharmacophore interferes with the function of the enzyme.

5 'Imatinib' is a drug that was designed to combat leukaemia, a cancer of the blood. 'Imatinib' was developed as a result of work on three different compounds (**A**, **B** and **C**).

Compound **A** was found to have anti-leukaemia effects. Compound **B** was then found to be more effective and compound **C** more specific. 'Imatinib' was developed from compound **C**.



Compound A **Compound B** **Compound C**



'Imatinib'

It has a complementary shape to the enzyme (1) so fits into the active site (1) blocking the <u>substrate</u> from entering. (1)

shape: it has correct shape/ similar shape to substrate/ complementary shape to the enzyme/active site ✓ *binds:* to fit into/binds/bonds with active site ✓ *blocking:* blocking it to <u>substrate</u>/competing with <u>substrate</u> AW✓	4	**QWC**: word 'substrate' must be used and spelled correctly to score third marking point.

Explain how specific pairing suggests a copying mechanism for the replication of DNA? [3]

Explain:

- how the adenine–thymine and guanine–cytosine base pairs are held together, stating the difference between the two different pairs
- how the specific pairing 'suggests a copying mechanism' for the replication of DNA.

In your answer, you should link the making and breaking of bonds between base pairs to the ability of DNA to replicate itself.

..... **[5]**

- Hydrogen bonds break between base pairs [1]
- Two single strands are formed (helices) [1]
- Each base forms hydrogen bonds to a new complementary base [1]

base pairs held together by hydrogen bonding/bonds ✓ adenine-thymine 2 hydrogen bonds **AND** guanine-cytosine 3 hydrogen bonds ✓ **hydrogen bonds** between base pairs **break** ✓ (two single) **helices / strands** are formed ✓ **each base** (on these helices/strands) forms **hydrogen bonds** to a **new (correct/complementary) base** AW ✓ ✓ to gain this last point replication must be linked to breaking **AND** forming hydrogen bonds	**5**	May be implied by staying the number of hydrogen bonds in each case different numbers of H bonds is **NGE** May refer to just **one strand** **IGNORE** references to phosphodiester bonds *i.e.* both forming and breaking H bonds have to be mentioned in the answer

From F334 paper old spec so your choice whether you want to learn for new spec or not

What is the reason that CO and N_2 can be distinguished by high-resolution mass spectrometry?

24 CO and N_2 both have M_r values of 28.

What is the reason that CO and N_2 can be distinguished by **high-resolution** mass spectrometry?

A CO has a dipole, unlike N_2.

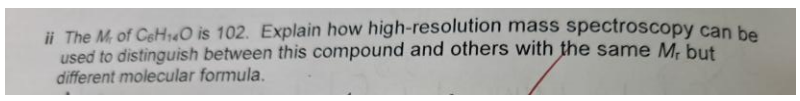
B CO is more reactive than N_2.

C The values of their M^+ peaks would be different.

D CO and N_2 would give different fragments.

Your answer ☐ **[1]**

- C as high resolution mass spec is to 4 decimal places



The M_r of $C_6H_{14}O$ is 102. Explain how high-resolution mass spectroscopy can be used to distinguish between this compound and others with the same Mr but difference molecular formula? (3)

- As the mass spec can see the M_r to 4d.p
- Different compounds have different M_r values in the decimal places
- Atoms of the element have A_r value that are not exact whole numbers

(i) Give **one** advantage and **one** disadvantage of using enzymes in industrial processes

Give 1 advantage and disadvantage of using enzymes in industrial processes?

Advantage: Allows faster reaction at lower temp/ saves fuel ✓
Disadvantage: easily denatured/inhibited/ sensitive to pH/ difficult to recover after use. ✓

Advantages
- Allow faster reaction at lower temperatures
- Saves fuel

Disadvantages
- Easily denatured
- Inhibited
- Sensitive to pH
- Difficult to recover after use

The student repeats the experiment for trypsin at 70 °C, well above the optimum temperature, which is 40 °C.

Describe the appearance of the graph of rate of reaction against substrate concentration at 70 °C.

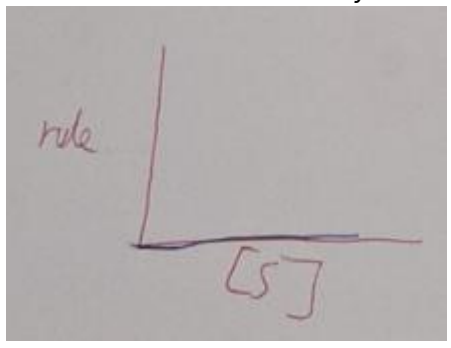
Explain your answer.

..... **[2]**

Describe the appearance of the graph of rate against [S] at 70 degrees?

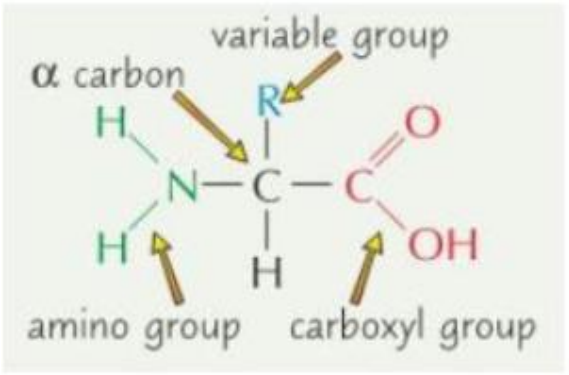
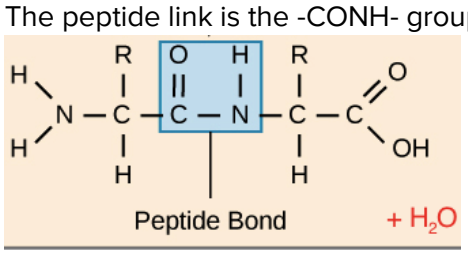
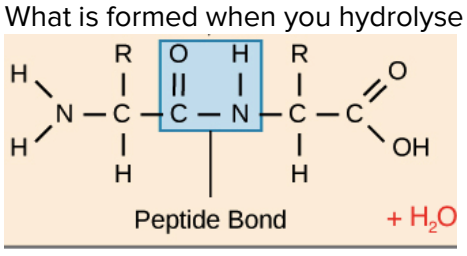
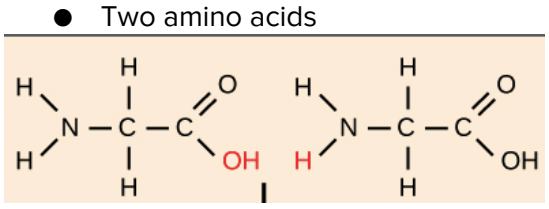
e	**ii**	straight line (parallel to x-axis) at rate = 0 ✓ active site is destroyed / changes shape ✓	**2**	may draw a diagram **ALLOW** line along the x-axis **IGNORE** denatured

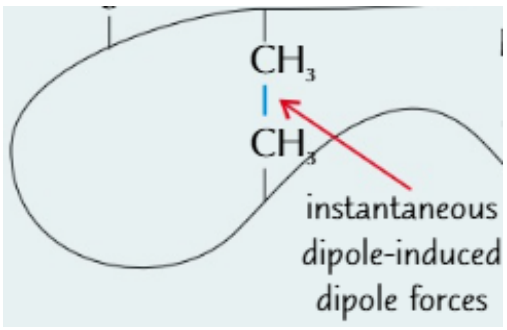
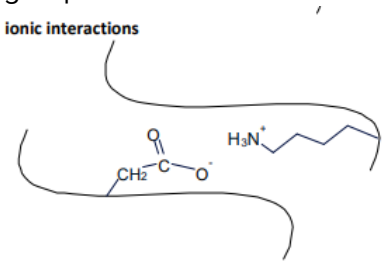
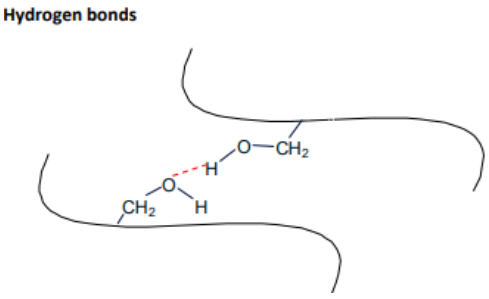
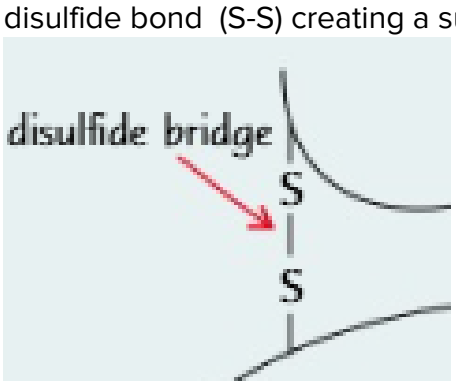
- Straight line at rate = 0
- Active site is destroyed so changes shape

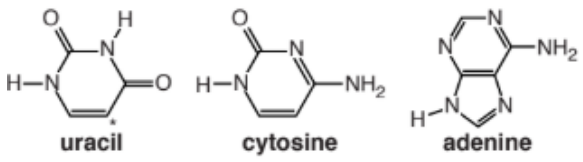
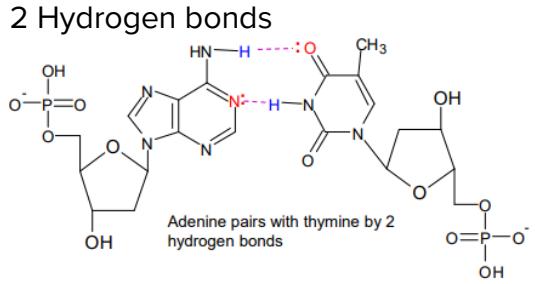
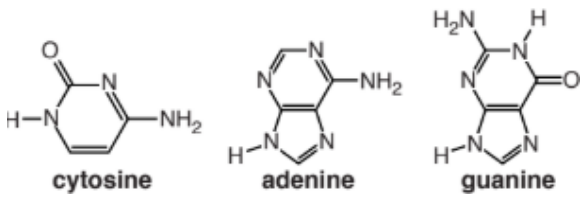
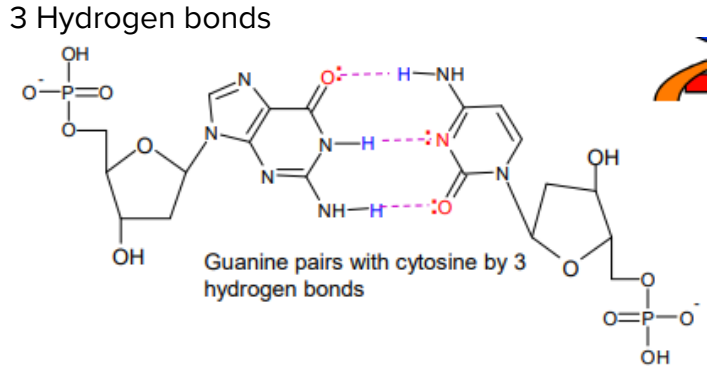
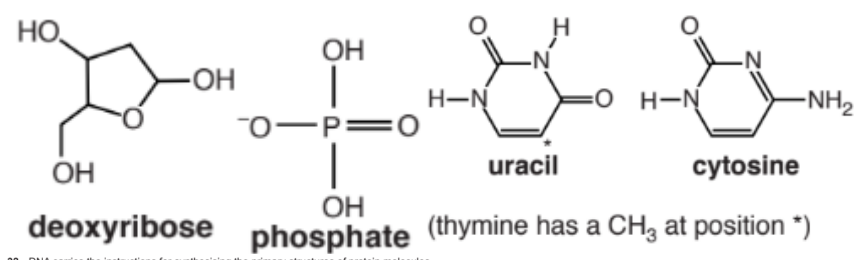
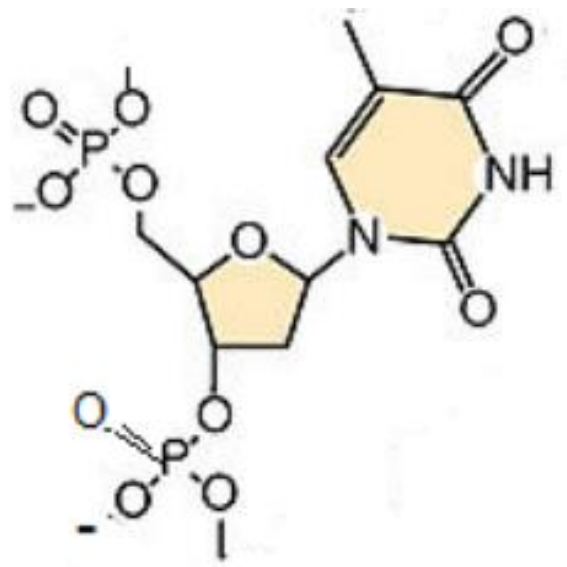


PL.a-e - Structure & Bonding | PL4 | PL5 | PL7 | PL8 |

What are amino acids? And draw general structure	A central carbon with an amine and a carboxyl group

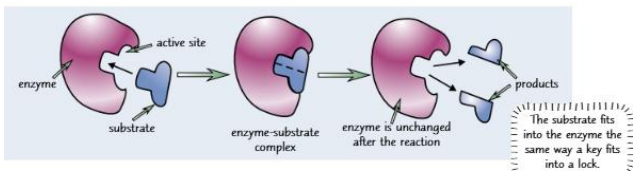
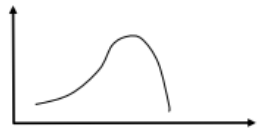
	
When and where is a peptide link formed?	When two amino acids (also know as amino acid residue) join together via the -NH2 group and the -COOH group to produce a secondary amide group -CONH- The peptide link is the -CONH- group  *This is condensation polymerisation as water is formed*
What is formed when you hydrolyse a protein (amino acid residue)? 	● Two amino acids 
Describe the set-up procedure for paper chromatography?	● **Draw** a pencil line on chromatography paper * ● **Line** must be above solvent level (so depth of solvent must be lower than the line) * ● **Spot** mixture and pure samples onto paper line (evenly spread) * ● **Place** paper in a beaker of solvent * ● **Cover** and **suspend** the paper in the beaker with a lid * ● **Remove** paper when solvent front is near to top of paper ● **Mark** how far solvent has reached (in pencil) ● **Allow** paper to dry (by placing in a fume cupboard to evaporate solvent) ● **Locate** any spots by spraying ninhydrin solution (as well as using iodine crystals or using a UV lamp) ● More than one spot would indicate hydrolysis Use mnemonic Remember this as DLSPCRMAL Do Line Solvent Properly Cause Ryan May Analyse Light * Can be achieved by drawing a labelled diagram
Describe the analysis of a paper chromatography	● After locating any spots ● Measure Rf values of spots (distance travelled by spot/distance travelled by solvent) ● Look up Rf values for the spotted amino acids ● Compare them with measured values / reference amino acids
What are proteins?	Proteins are polymers that are made up of amino acid monomer units known as poly(peptides) or poly(amino acids)
What are the Definitions for a primary, secondary (1) and tertiary structures (1) for a protein?	● Primary structure: The sequence of amino acids (residues) ● Secondary structure: The folding of the chains into helices or sheets (1) ● Tertiary structure: The folding of a secondary sheet forming a 3D shape (1)
What is the force that holds secondary protein structures?	Hydrogen bonds (between -NH and C=O groups) ***It holds both α-helix and β-Pleated structures***
What are the 4 forces that holds tertiary protein structures?	1. Id-Id forces 2. Ionic bonds 3. Hydrogen bonding 4. Covalent bonds

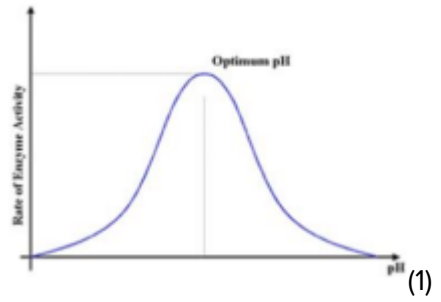
How does Id-Id forces hold tertiary protein structures?	Weak attractions exist between non-polar groups on the amino acid chain 
How does ionic bonds hold tertiary protein structures?	There could be a transfer of a hydrogen ion from a -COOH to a NH2 group to form zwitterions  Ionic interactions could form between acidic amino acids such as aspartic acid and basic amino acids such as lysine. There is a transfer of a hydrogen ion from the -COOH to the -NH_2 group to form zwitterions just as in simple amino acids.
How does hydrogen bonds hold tertiary protein structures?	Hydrogen bonding exists between FON elements with an H. In amino acids this is -NH2 and-OH  Hydrogen bonds could form between two serine side chains in different parts of the folded chain. (Other amino acids chains can also hydrogen bond)
How does covalent bonds hold tertiary protein structures?	Cysteine is an amino acid that has a thiol group (-SH). They can lose the H atom (being oxidised) and the sulfur atoms can form a disulfide bond (S-S) creating a sulfur bridge. 
What are the 4 components of DNA with examples and what is DNA formed from?	● Phosphate ● Sugar - deoxyribose sugar ● Base - A,T,C,G ● 2 polynucleotide strands *U - uracil is not INCLUDED*
What are the 3 components of RNA and anticodon pattern? with examples	● Phosphate ● Sugar - ribose sugar ● Base - A,U,C,G ● Anti codon to base pattern, U,A,G,C *T - Thymine is not INCLUDED*
What are the 3 differences between DNA and RNA?	● DNA has a different sugar to RNA ● DNA has a different base to RNA ● DNA has a double strand whilst RNA is single stranded

What holds Adenine and Thymine together in DNA? And draw just that section of the bond  uracil cytosine adenine (thymine has a CH_3 at position *)	2 Hydrogen bonds  Adenine pairs with thymine by 2 hydrogen bonds
What Holds Cytosine and Guanine together in DNA? And draw just that section of the bond  cytosine adenine guanine	3 Hydrogen bonds  Guanine pairs with cytosine by 3 hydrogen bonds Remember as OHH HNO
Draw the structure of 2 phosphate units, 1 deoxyribose sugar and 1 thymine unit as a condensation polymer?  deoxyribose phosphate uracil cytosine (thymine has a CH_3 at position *) 32 DNA carries the instructions for synthesising the primary structures of protein molecules. Its backbone consists of alternating phosphate and deoxyribose sugar units. Bases are attached to the sugar units. (a) Use the Data Sheet to draw a section of DNA. The section of DNA must consist of two phosphate units, one deoxyribose sugar unit and one thymine unit, all joined by condensation reactions. [3]	 ● **BOTH bonds** between phosphate and sugar ● Bond between sugar and base ● All other details correct ***Allow*** *phosphates with minus sign or 'spare bonds' or -OH groups* *Tip: start with the pentagon and make sure to draw 3 bonds between the Phosphate and sugar not 2 (P-O-CH2-C)*
What does the backbone entail of in DNA/RNA and what would be its repeating units in DNA?	● Sugar - deoxyribose/ribose sugar ● Phosphate ● Repeating unit: deoxyribose-phosphate-deoxyribose-phosphate or vice versa
What is a nucleotide and what do they represent?	A phosphate-sugar-base group and they represent the monomers of a DNA/RNA chain *They also describe a repeating unit in a DNA chain* ***Mark schemes do not allow base-sugar-phosphate group as from the PL test MCQ***
Define Pharmacophore? (1) Explain the term **pharmacophore**. ....[1]	A part of a molecule that is responsible for a particular biological activity (or pharmacological activity, medicinal activity) [1]
What 4 things does the 'fit' of a pharmacophore into a receptor site depend on?	1. Size and shape 2. Bond formation (id-id,ionic,covalent,hydrogen) 3. Orientation (e/z,cis/trans,optical)
How does Size and shape affect the 'fit' of a pharmacophore into a receptor site?	The pharmacophore has to have a particular structure that will fit into the receptor site

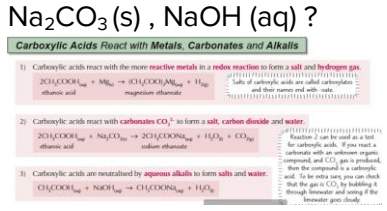
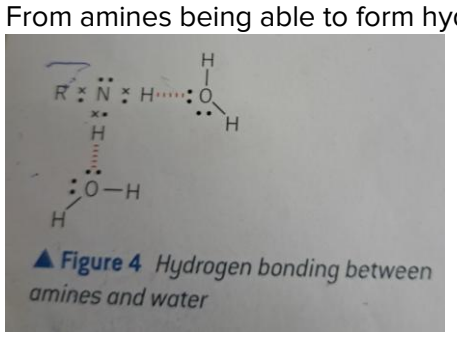
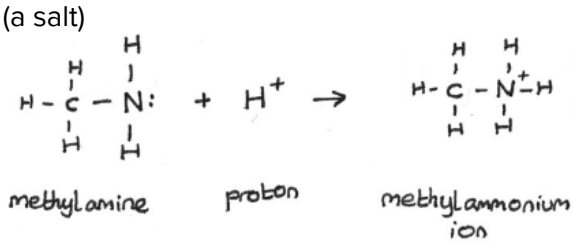
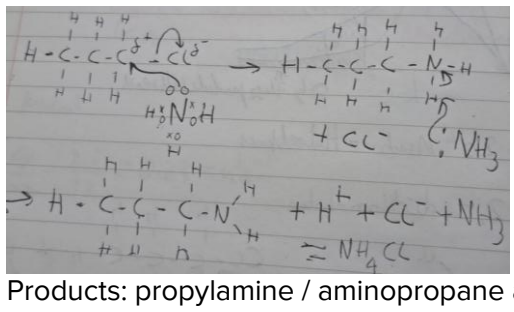
How does bond formation affect the ‘fit’ of a pharmacophore into a receptor site?	● Id-id interactions - can form with the receptor site ● Hydrogen bonding from functional groups such as -NH2, -OH or -COOH with the receptor site ● Ionic bonds - from acidic and basic functional group so forms electrostatic attractions with the receptor site
How does orientation affect the ‘fit’ of a pharmacophore into a receptor site?	If the pharmacophore has E/Z or/and optical isomers then only **ONE** of the isomers will fit

PL.f-g - Kinetics | PL6 |

How does an enzyme work?	A substrate fits into the active site as it has a complementary shape to it and so would lower the activation enthalpy then the substrate reacts and the products leave the active site E + S -> ES -> EP -> E + P
Describe an active site and give its function (3)? **(b).** Trypsin has an active site. Describe an *active site* and give its function. **[3]**	● A specific shape in the enzyme (1) that fits (1) a substrate being broken down (1) a hole / cleft / crevice / specific shape (in the enzyme structure) AW ✓ substrate/ protein binds / fits / bonds ✓reaction/ hydrolysis occurs / substrate is broken down / conversion into products ✓ 3 **ALLOW** part of protein tertiary structure **ALLOW** shape in enzyme which fits substrate **ALLOW** catalyse reaction between enzyme and substrate **Examiner's Comments** Most were able to follow on to discuss successfully the function of the 'active site' in an enzyme. These first two parts clearly gave candidates confidence to tackle the challenges ahead.
What are the 4 characteristics of enzyme catalysis?	● Specificity ● Temperature sensitivity ● pH sensitivity ● Competitive inhibition *Enzymes are biological catalysts*
How does Specificity affect enzyme catalysis?	Enzymes only work with specific substrates because the substrate has to fit into the active site. This is called the ‘lock and key’ model 
How does Temperature sensitivity affect enzyme catalysis?	At low temperatures Reactants would have low kinetic energy thus not the activation enthalpy -> slow reaction At high temperatures The enzyme will begin to denature as the tertiary structures containing imf would break so the active site is destroyed -> slowing the rate of reaction
Draw the shape of a Rate of enzyme activity/ temperature graph and Explain the shape if optimum temp = 37 degrees C?	 Shape of graph: rises to peak, then falls ✓ Initially as temperature increases more collisions above E_A, so increasing rate ✓ then the kinetic energy breaks imbs in active site and it loses its specific shape and substrate can't bind. ✓ **ALLOW** enzyme becomes denatured ● Peak of curve above 37 degrees ● Initially as temperature increase there are more collisions above E_a so increases rate (1) ● Then the KE breaks imbs in active site so loses its specific shape and substrate can’t bind (1) *Depending on how extreme the temperature is, **some** mark schemes don’t allow denatured*
How does pH sensitivity affect enzyme catalysis?	At high or low pH’s The enzyme will begin to denature as the tertiary structures containing imf would break so the active site is destroyed -> changes the tertiary structure -> the active site is no longer the correct shape for the substrate to fit into -> slowing the rate of reaction

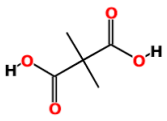
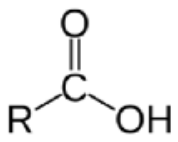
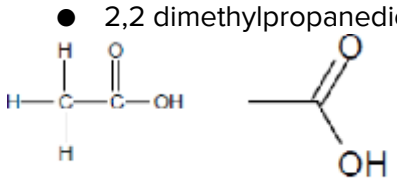
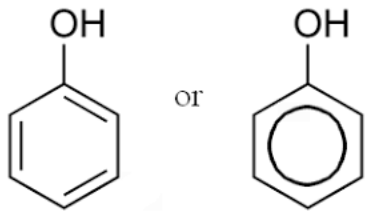
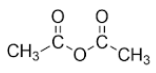
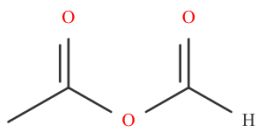
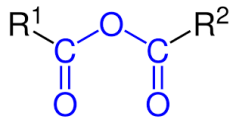
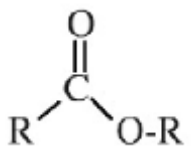
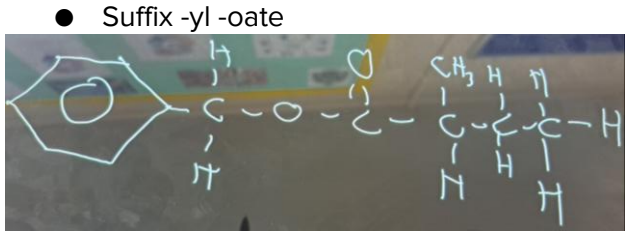
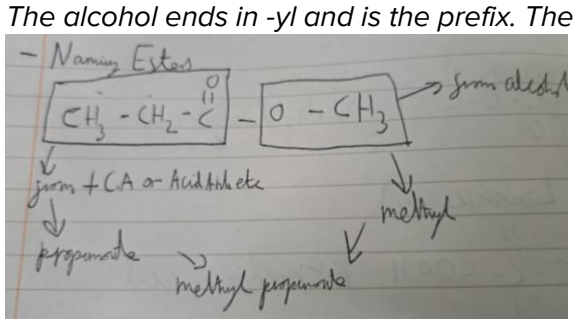
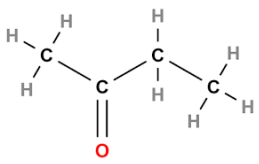
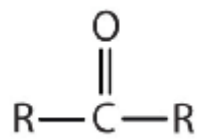
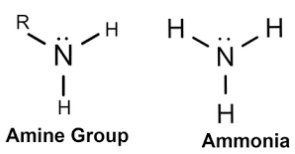
Draw the shape of a rate of enzyme activity / pH graph and Explain the shape if the optimum pH = 8? (3)	 (1) ● Peak of curve above pH 8 (1) ● At other pH values the active site becomes destroyed (1) *Depending on how extreme the pH is, **some** mark schemes don't allow denatured*
How does Competitive inhibition affect enzyme catalysis?	An inhibitor has a similar shape to the substrate so also fits into the active site which blocks it -> the substrate cannot bind to which there would be no active sites available to the substrate slowing down the rate of reaction

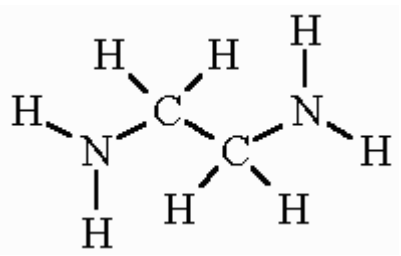
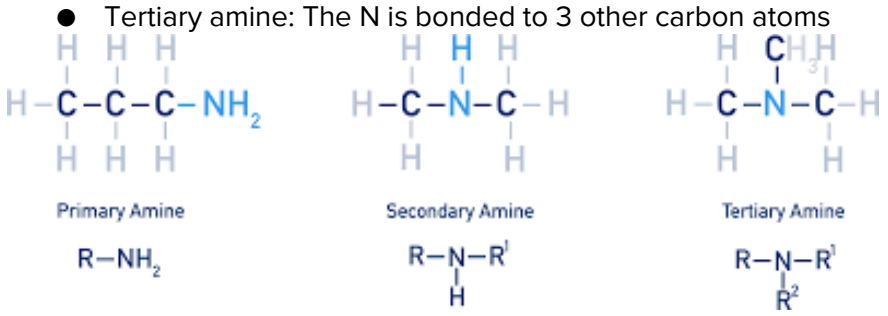
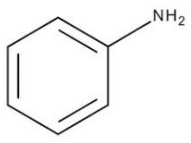
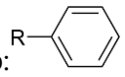
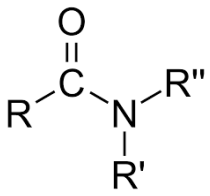
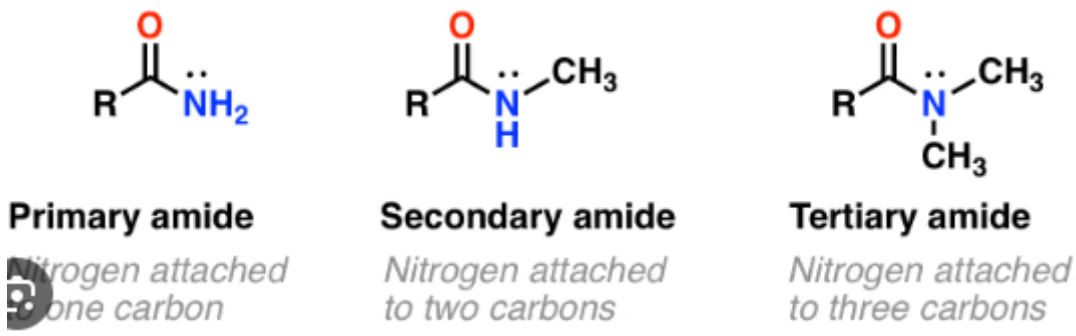
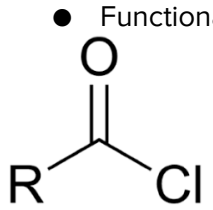
PL.h-j - Equilibria (acid-base) | PL1 | PL2 | PL4 |

What are salts of carboxylic acids called? Like $Na^+(CH3COO^-)$	Carboxylates and sodium ethanoate
What are the products of the reactions of ethanoic acid with Mg(s), Na_2CO_3 (s) , NaOH (aq) ? 	● Ethanoic acid + Magnesium -> Magnesium ethanoate $Mg(CH_3COO)_{2\ (aq)} + H_{2\ (g)}$ ● Ethanoic acid + Sodium carbonate -> Sodium ethanoate $Na(CH_3COO)_{\ (aq)} + H_2O_{\ (l)} + CO_{2\ (g)}$ ● Ethanoic acid + Sodium Hydroxide $NaOH_{(aq)}$ -> Sodium ethanoate $Na(CH_3COO)_{\ (aq)} + H_2O_{\ (l)}$
What are the 4 properties of amines?	● They are soluble in water ● They can act as bases ● They can act as nucleophiles ● They can act as ligands (learned in developing metals-topic 9)
Why are amines soluble in water?	● From CH_3NH_2 (aq) + H_2O (l) -> $CH_3NH_3^+$ (aq) + OH^- (aq) where the methylammonium is an ion so is soluble in water ● From amines being able to form hydrogen bonds with water 
What do amines primarily react as?	Bases. Eg, they react with HCl to produce methylammonium chloride (a salt)  This equation doesn't include the Cl^- ion
Draw the two step nucleophilic substitution of 1-chloropropane with ammonia as the nucleophile?	 Products: propylamine / aminopropane and Ammonium chloride
Define Zwitterions?	A molecule with both positive and negative ions

PL.k-l - Organic functional groups | PL1 | PL2 |

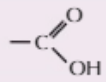
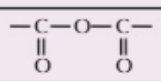
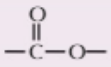
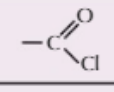
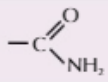
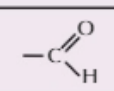
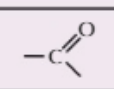
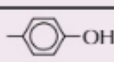
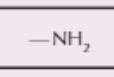
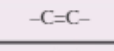
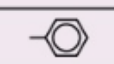
Functional group, prefix and suffix of carboxylic acids and name this compound	● Functional group:

	 ● Prefix: carboxy- (dicarboxy-) ● Suffix: -oic acid (-dioic acid) ● 2,2 dimethylpropanedioic acid  *E.g., ethanoic acid.* ● General formula: $C_nH_{2n+1}COOH$
Functional group, prefix and suffix of phenols	● Functional group  ● Prefix: hydroxy- (dihydroxy-) ● Suffix: -phenol
Functional group and suffix of acid anhydrides and name this compound  	● Functional group:  ● Suffix: -oic anhydride ● Ethanoic anhydride *The branches from R_1 and R_2 are always symmetrical for this course*
Functional group and suffix of esters and name this group and also draw the structure of phenylmethyl 2 methylbutanoate	● Functional group: ● General formula: $C_nH_{2n}O_2$  ● Suffix -yl -oate  *The alcohol ends in -yl and is the prefix. The carboxylic acid ends in -anoate and is the suffix* 
Functional group and suffix of ketones and name this compound 	● Functional group:  ● ● General formula: $C_nH_{2n}O$ ● Suffix: -one ● butan2-one
Functional group, prefix and suffix of amines? And name this compound	● Functional group: R-NH_2 

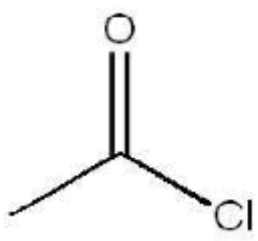
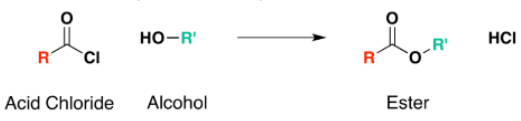
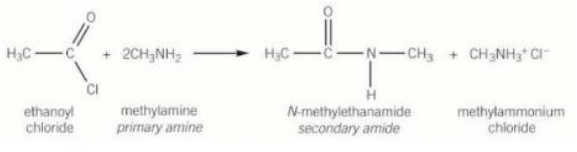
	● Prefix: amino- (diamino-) ● Suffix: -amine (-diamine) ● Ethane1,2,diamine / 1,2diamino ethane
What are the 3 types of AMINES?	● Primary amine: The N is bonded to 1 other carbon atom ● Secondary amine: The N is bonded to 2 other carbon atoms ● Tertiary amine: The N is bonded to 3 other carbon atoms 
Functional group, prefix and suffix of arenes? And name this compound? 	● Functional group:  ● Prefix: phenyl- ● Suffix: -benzene ● Phenylamine / aminobenzene
Functional group and suffix of amides?	● Functional group: R-C=O-NH_2  ● Suffix: -amide (-diamide)
What are the 3 types of AMIDES?	● Primary amide: The N is bonded to 1 other carbon atom ● Secondary amide: The N is bonded to 2 other carbon atoms ● Tertiary amide: The N is bonded to 3 other carbon atoms 
Functional group and suffix of acyl chlorides?	● Functional group: R-C=O-Cl  ● Suffix: -oyl chloride (-dioyl chloride)

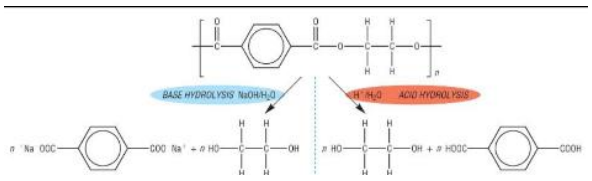
Functional Groups are the *Most Important Parts* of a Molecule

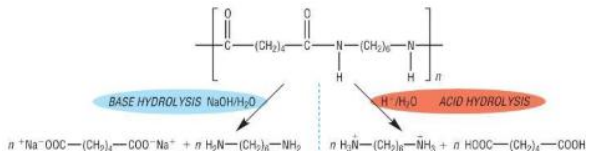
Functional groups are the parts of a molecule that determine how the molecule **reacts**. Here's a **summary** of the ones you need to know, in order of their **priority**. Some you've met, and some you'll learn about in the next few pages.

Homologous Series	Functional Group	General Formula	Prefix / Suffix	Example
Carboxylic acids (including dicarboxylic acids, p. 168)		$C_nH_{2n}O_2$	carboxy- / -oic acid (dicarboxy- / -dioic acid)	ethanoic acid
Acid anhydrides		$C_nH_{2n-2}O_3$	-oic anhydride	ethanoic anhydride
Esters		$C_nH_{2n}O_2$	-oate	methyl ethanoate
Acyl chlorides		$C_nH_{2n-1}OCl$	-oyl chloride	ethanoyl chloride
Amides		$C_nH_{2n-1}ONH_2$	-amide	ethanamide
Aldehydes		$C_nH_{2n}O$	-al	ethanal
Ketones		$C_nH_{2n}O$	-one	propanone
Alcohols including diols (p. 165)		$C_nH_{2n+1}OH$	-ol / hydroxy- (-diol / dihydroxy-)	ethanol
Phenols		RC_6H_4OH	-phenol	3-ethylphenol
Primary amines including diamines (p. 166)		$C_nH_{2n+3}N$	-amine / amino- / -diamine / diamino-	aminoethane
Alkenes		C_nH_{2n}	-ene	ethene
Arenes		RC_6H_5	-benzene / phenyl-	ethyl benzene
Alkanes	Only C–C and C–H	C_nH_{2n+2}	-ane	ethane
Ethers	R–O–R′	$C_nH_{2n+2}O$	alkoxy-	methoxy ethane
Haloalkanes	–X	$C_nH_{2n+1}X$	fluoro- / chloro- / bromo- / iodo-	chloroethane

PL.m-n - Organic reactions | PL2 | PL3 |

When are nylons (polyamides) made? How are they named?	A diamine and a dicarboxylic acid (or diacyl chloride) reacting together to make an ester and a small molecule via condensation polymerisation (most of the time) If 2 monomers are used its the number of carbon atoms in the diamine then its the number of carbon atoms in the dicarboxylic acid [or diacyl chloride] (including the ones in the carboxyl groups) i.e. nylon-6,6 & nylon-6,10 If 1 monomer is used its the number of carbon atoms in the amine or carboxylic acid (or acyl chloride) section of a monomer and the monomer contains an amine + carboxylic acid [or acyl chloride] group (including the ones in the carboxyl groups) i.e. nylon 6
How and why are acyl chlorides better than carboxylic acids?	They are more reactive than carboxylic acid as Cl is a good leaving group 
How do acyl chlorides react with alcohols and why is it good?	● To produce an ester ● It's faster (-> more reactive) and not reversible compared to carboxylic acids  Acid Chloride Alcohol Ester *Note: This occurs via nucleophilic substitution at RTP*
How do acyl chlorides react with primary and secondary amines? (with example equation)	● To produce secondary and tertiary amides respectively ● Example:  ethanoyl chloride; methylamine *primary amine*; *N*-methylethanamide *secondary amide*; methylammonium chloride *The N means that the methyl group is bonded to the nitrogen rather than the main carbon chain and this occurs via nucleophilic substitution*
What 2 things are common for most reactions of a acyl chlorides?	1. Carried out at room temperature 2. Any HCl (g) is given off as steamy white fumes

Give 2 ways esters can be hydrolysed and what does it form (with conditions)	1. **<u>Heating with moderately concentrated ACID (e.g H_2SO_4/HCl)</u>** ● Use sulfuric acid catalyst under reflux ● Forms the original reactants ● $CH_3COOCH_3 + H_20 \rightleftharpoons CH_3COOH + CH_3OH$ (reversible so doesn't give a good yield) 1. **<u>Heating with moderately concentrated Alkali (e.g NaOH) [Saponification]</u>** ● Use sodium hydroxide under reflux ● Forms a carboxylate ion (CH_3COO^-) and alcohol ● $CH_3COOCH_3 + OH^- \rightarrow CH_3COO^- + CH_3OH$ ● $CH_3COO^- + Na^+ \rightarrow Na(CH_3COO)$ ● $Na(CH_3COO) + CH_3OH$ (not reversible so high yield) *The carboxylic acid turns into a carboxylate ion (from giving a H to the amine) and then reacts with the sodium ions in this case to form sodium propanoate* *The anion in the salt is resistant to attack by weak nucleophiles such as the alcohol so this reaction isn't reversible*
Give 2 ways amides can be hydrolysed and what does it form (with conditions) [Secondary amide for acid + alkali catalyst]	1. ***H*eating with moderately concentrated ACID (H_2SO_4, e.g HCl)** ● Use conc sulfuric acid catalyst under reflux ● Secondary amide forms a carboxylic acid + ammonium salt ● $CH_3CONHCH_3 + H_2O \rightarrow CH_3COOH + NH_2CH_3$ ● $NH_2CH_3 + H^+ \rightarrow NH_3^+CH_3$ ● $CH_3COOH + NH_3^+CH_3 + Cl^-$ *Please remember that a H is given to the NHR by the water to form NH2R and another H^+ is from the acid catalyst to form an ammonium salt ($NH3^+R$)* 1. **<u>Heating with moderately concentrated Alkali (e.g NaOH)</u>** ● Use sodium hydroxide under reflux ● Secondary amide forms a carboxylate ion and an amine ● $CH_3CONHCH_3 + OH^- \rightarrow CH_3COO^- + CH_3NH_2$ ● $CH_3COO^- + Na^+ + \rightarrow Na(CH_3COO)$ ● $Na(CH_3COO) + CH_3NH_2$ *The carboxylic acid turns into a carboxylate ion (from giving a H from OH^- to the amine) and then reacts with the sodium ions in this case to form sodium ethanoate*
How are primary amides hydrolysed to carboxylic acids? (reagents, type of reaction, equation)	● Reagents: moderately concentrated HCl (aq) ● Type of reaction: acid hydrolysis ● Equation: ● $CH_3CONH_2 + H_2O \rightarrow CH_3COOH + NH_3$ ● $NH_3 + H^+ \rightarrow NH_4^+$ ● $NH_4^+ + Cl^- \rightarrow NH_4Cl$ ● $CH_3COOH + NH_4Cl$ *Please remember that a H is given to the NH2 by the water to form NH3 and another H^+ is from the acid catalyst to form an ammonium salt ($NH4^+$) then if the catalyst has an anion like Cl^- for HCl then it would form NH_4Cl*
How are primary amides hydrolysed to ammonia? (reagents, type of reaction, equation)	● Reagents: moderately concentrated NaOH (aq) ● Type of reaction: alkali hydrolysis ● Equation: ● $CH_3CONH_2 + OH^- \rightarrow CH_3COO^- + NH_3$ ● $CH_3COO^- + Na^+ \rightarrow Na(CH_3COO)$ ● $Na(CH_3COO) + NH_3$ ● Primary amides when hydrolysed forms carboxylate ion and ammonia *The carboxylic acid turns into a carboxylate ion (from giving a H from OH^- to the amine) and then reacts with the sodium ions in this case to form sodium ethanoate*
What does the base and acid hydrolysis of poly(esters) produce?	 1. Base - dicarboxylate salt and diol 2. Acid = dicarboxylic acid and diol

What does the base and acid hydrolysis of poly(amides) produce?	 1. Base - dicarboxylate salt and diamine 2. Acid - dicarboxylic acid and diammonium

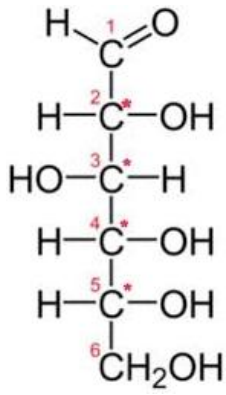
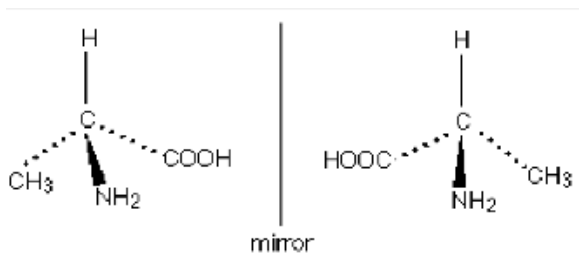
PL.o-p - Polymers | PL1 |

What is addition polymerisation?	When unsaturated monomers react e.g. an alkene
What is condensation polymerisation?	Two different monomers that add together with a small molecule usually given off as a side-product (eg, H_2O or HCl). *These monomers usually have the same functional group on both ends of the molecule (eg, diamine, dicarboxylic acid, diol, diacyl chloride).*
Give the 2 most common type of condensation polymers with their linkage?	1. Poly(esters) which contain an ester link (-COO-) e.g Terylene or PET 2. Poly(amides) which contain an amide link (-CONH-) also known as nylons e.g kevlar *They form what is called an ester linkage or amide linkage*

Differences Between Types of Polymerisation

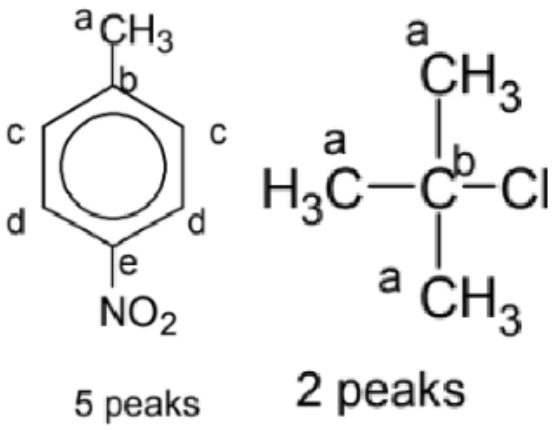
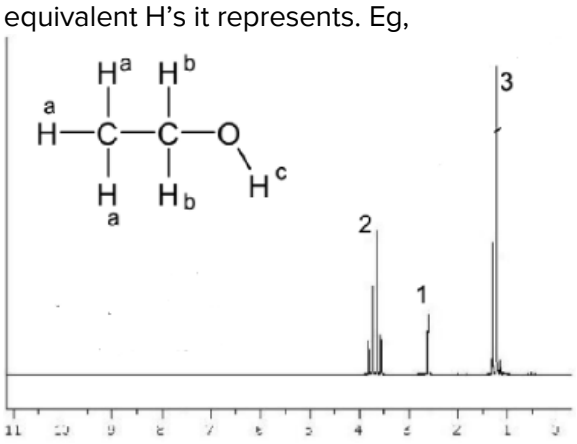
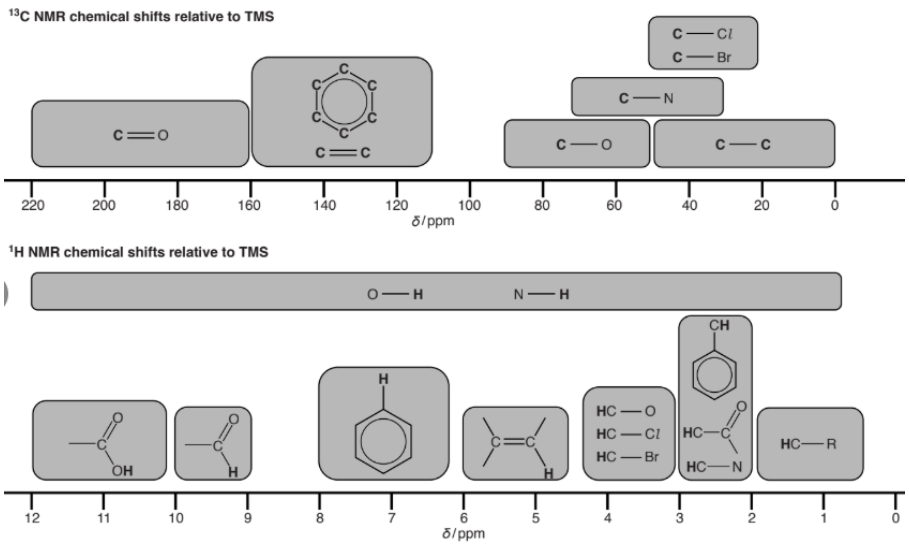
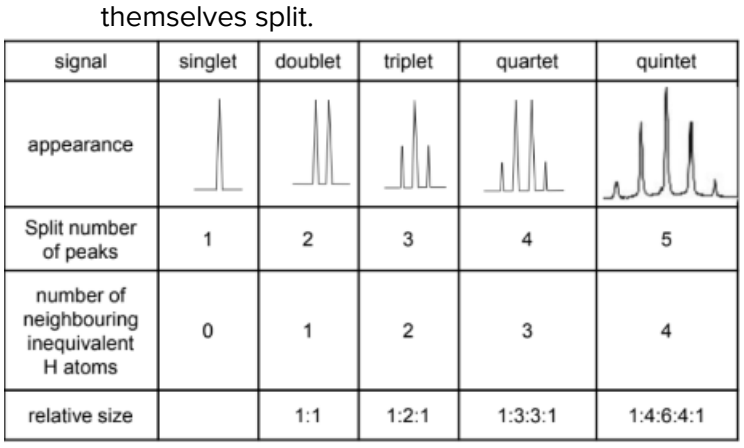
Addition polymerisation	**Condensation polymerisation**
Monomers contain C=C double bonds.	Monomers contain -OH and -COOH or -COCl functional groups in polyesters. Monomers contain $-NH_2$ and -COOH or -COCl functional groups in polyamides.
Main chain of the polymer only contains C-C single bonds.	Main chain contains nitrogen or oxygen atoms as well as carbon atoms.
The polymer is the only product of the reaction.	The polymer and a small molecule (like water or HCl) are formed during the reaction.

PL.q - Isomerism | PL4 |

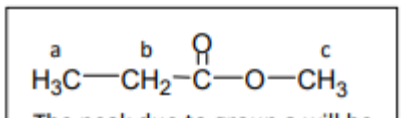
Define Chiral?	A carbon atom with 4 different groups attached to it  *In a molecule a chiral carbon is often identified with an asterisk **
Define Enantiomers isomers (optical isomers) and what is required of them?	● Stereoisomers which are non-superimposable mirror images of molecules ● 4 different groups attached to a carbon (called the chiral centre)  There are enantiomers / optical isomers. *- They can both be referred as enantiomers / optical isomers* *- They can be distinguished by shining plane-polarised light and seeing the angle of rotation.*

PL.r-t - Modern analytical techniques | PL9 | Nuclear Magnetic Resonance [NMR] **Learn through PRACTICE QUESTIONS NOT MEMORISING**

What does chemical shift / δ represent in NMR?	It is how far the frequency of a signal is shifted from TMS measured in

	parts per million (ppm)
What are equivalent carbons? How do they show up in Carbon-13 NMR?	Carbons which are in the same environment  There is one signal peak for each set of equivalent carbons
What can be determined from a Carbon-13 NMR spectrum?	● The number of carbon atoms that have different environments in a molecule ● Work out (sometimes only roughly) the groups to which these carbon atoms are attached
How do equivalent hydrogens differ from equivalent carbons in P NMR?	The intensity (peak integration value) proportional to number of equivalent H's it represents. Eg, 
How does electronegativity affect proton NMR?	If a H is closer to the more electronegative group, greater shift (further to the left on NMR spectrum) 
What is spin-spin coupling in high-resolution P NMR?	● Each signal can be split based on how many neighbouring **NON-EQUIVALENT** 1H's (neighbouring means within 3 bonds) ● Yet, hydrogens bonded to nitrogen or oxygen don't split or themselves split. 

signal	singlet	doublet	triplet	quartet	quintet
appearance					
Split number of peaks	1	2	3	4	5
number of neighbouring inequivalent H atoms	0	1	2	3	4
relative size		1:1	1:2:1	1:3:3:1	1:4:6:4:1

<table>
<tr>
<td></td>
<td>


The peak due to group a will be a triplet as it is next to b (a carbon with 2 H's)

The peak due to group b will be a quartet as it is next to a (a carbon with 3H's)

The peak due to group c will be a singlet as it is next to a carbon with no H's)

Split number of peaks = number of nonequivalent H's within 3 bonds + 1 (FOLLOWS THE n + 1 rule)
The relative sizes follow Pascal's triangle
</td>
</tr>
<tr>
<td>What table should be drawn for proton NMR?</td>
<td>
<table>
<tr><th>Chemical shift / ppm</th><th>Type of ^{1}H environment</th><th>Relative ^{1}H's</th><th>Assignment</th><th>Splitting</th></tr>
<tr><td>Range</td><td>Structure</td><td>Number</td><td>Colour / Shape</td><td>No. Peaks</td></tr>
</table>
</td>
</tr>
</table>