

VCE Chemistry Units 3&4

Suggested Solutions

Test 7: How are organic compounds analysed and used?

- Medicinal chemistry

SECTION A – MULTIPLE-CHOICE QUESTIONS

Question 1 C

C is an incorrect statement and so is the required response. A low viscosity, free-flowing solvent allows better penetration of the sample to aid extraction of the target substance.

A, B and D state favourable properties of solvents for extraction and so are not the required responses.

Question 2 C

C is correct. Fractional distillation involves boiling the mixture and selectively collecting the vapours of the components as they boil at different temperatures.

A, B and D are incorrect. These differences will not allow separation by distillation.

Question 3 C

C is correct. This shows the peptide link formed by reaction of a carboxyl and an amino group.

A, B and D are incorrect. They show the ester link in triglycerides, the ether link in carbohydrates, and a peroxide link respectively.

Question 4 B

B is correct. In structure I the hydrogens of the CH_3 attached to the N atom have no neighbours and so would show as a single, unsplit peak. In structure II the hydrogens of the CH_3 in the ether groups will form an unsplit peak. In structure III the hydrogen of the OH group will be a singlet, unsplit peak.

A is incorrect. The molecules all contain the amine (NH_2 or NHR or NR_2) group, not the amide group (CONH).

C is incorrect. Based on their structures alone there is not enough similarity to assume similar pharmacology. They do all act as hallucinogens, but this similarity cannot be inferred from their structures.

D is incorrect. Structures II and III do not contain a carbon–carbon double bond. The bonds in the benzene ring are not double bonds.

Question 5 D

D is correct. Peptide links are strong, covalent bonds formed by reaction of an amino and a carboxyl group. They are within the polypeptide chain and are not broken by mild heating near to the optimal temperature.

A, **B** and **C** are incorrect. These weaker intermolecular bonds that are part of the secondary and tertiary structure are altered, and may be broken, by heating to mild temperatures.

Question 6 A

A is correct. Reaction occurs between the carboxyl group of one amino acid and the amino group of another amino acid. A water molecule is produced in this condensation reaction. Many condensation reactions occur to form the polymer of amino acids joined by peptide links.

B, **C** and **D** are incorrect. These options incorrectly state the reaction type and/or the role of water.

Question 7 A

A is correct. The two forms are optical isomers; that is, non-superimposable mirror images. Their chemical and physical properties are the same, except for their effect on a beam of plane polarised light and their interaction with other chiral molecules in biological systems.

B, **C** and **D** are incorrect. These properties and measures will be the same for both isomers.

Question 8 B

B is correct. In acidic conditions (pH 3) the amino acid will act as a base and accept a proton. The structure in **B** shows the protonated form of phenylalanine.

A is incorrect. This shows the unionised molecule.

C is incorrect. This is the deprotonated form found in solutions of high pH.

D is incorrect. This shows the zwitterion (dipolar ion) that forms for phenylalanine at a pH of 5.9.

Question 9 D

D is correct. Enzymes, like other catalysts, operate by lowering activation energy, allowing reactions to occur with less energy required to initiate the reaction. Reactions therefore occur at a faster rate.

A is incorrect. Enzymes significantly increase the rate of reactions, some by a factor of 10^{10} .

B is incorrect. Enzymes are specific and catalyse one or a small number of related reactions.

C is incorrect. Enzymes have an active site that binds to the substrate, but the bonds formed are weak, intermolecular bonds, not strong covalent bonds.

Question 10 D

D is correct. Rate of reaction increases steadily and then quickly drops to near zero. This is indicative of the denaturing of the enzyme and its subsequent inability to catalyse the reaction. Temperatures above 40°C denature many enzymes found in the human body.

A and **B** are incorrect. These variables would result in a graph that rises steadily and then reaches a plateau when another factor becomes limiting.

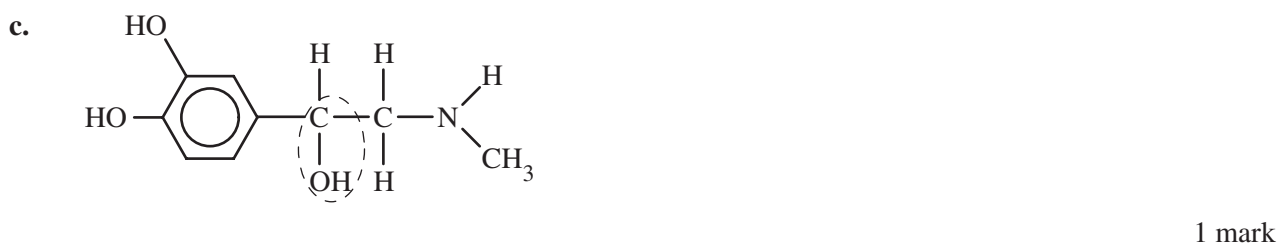
C is incorrect. It is unlikely that an enzyme would function across such a wide range of pH values before becoming denatured at pH 14. The pH range for activity by many enzymes spans only a narrow range of pH values.

SECTION B**Question 1** (13 marks)

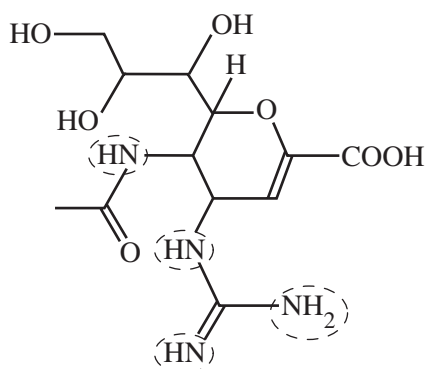
- a.** The knowledge of the three-dimensional structure allows for identification of the active site of the protein being targeted. 1 mark
- Drugs can then be designed with a size and shape to complement the shape of this active site (and so inhibit its function). 1 mark
- b.**
- i.** peptide link (amide bond) 1 mark
- ii.** The covalent bond of the peptide link is a strong bond, and so harsh reaction conditions are needed to break the bond. 1 mark
- c.**
- i.** Both contain an amine group. 1 mark
- ii.** The trypsin enzyme has an active site that temporarily binds to the molecular arrangement of the substrate molecule (the arginine residue in the protein). 1 mark
- The structural arrangement on the carboxyl side of the peptide link has a different shape to the amino side of the link. The shapes of the substrate and enzyme must match, so only one side of the link is cleaved by the enzyme action. 1 mark
- d.** The mixture of individual amino acids can be separated and collected using high-performance liquid chromatography (HPLC). 1 mark
- The different structures of the amino acids mean that they bind differently to the stationary phase of the HPLC column. They also show differing solubilities in the mobile phase of the HPLC process. 1 mark
- Differing adsorption and desorption leads to different rates of movement through the column and so separation and collection is achieved. 1 mark
- e.** Changing the pH of the solution can lead to protonation or deprotonation of basic and acidic side groups of the amino acids in the protein chain of the enzyme. 1 mark
- These changes alter the bonding between the side groups and so alter the tertiary structure of the enzyme. 1 mark
- With altered structure, the enzyme–substrate interaction is affected and so the catalytic activity of the enzyme diminishes. 1 mark

Question 2 (5 marks)

- a. i. amino (NH_2 and NHCH_3) 1 mark
- ii. hydroxyl (OH) 1 mark
- iii. ether ($\text{C}-\text{O}-\text{C}$) 1 mark

**Question 3** (7 marks)

- a. The drug may be able to be broken down in the digestive system and so would never reach its target protein site. 1 mark
- b. i. The drug must be absorbed into the bloodstream and be transported around the body in a primarily aqueous medium. 1 mark
- High solubility allows for more efficient transport of the drug in the bloodstream. 1 mark
- ii. There are several polar functional groups in the molecule (OH , NH_2 and COOH). 1 mark
- These can all hydrogen bond to water molecules and so the drug molecule can be dissolved in the water. 1 mark
- iii. Any one of the following circled functional groups:



- 1 mark
- c. This describes a reaction in which water is a reactant and becomes split during the reaction. 1 mark