RAFFLES INSTITUTION
2024 YEAR 6 PRELIMINARY EXAMINATION

Higher 2

CHEMISTRY
Paper 1 Multiple Choice

9729/01
19 September 2024
1 hour

Additional Materials: Multiple Choice Answer Sheet
Data Booklet

READ THESE INSTRUCTIONS FIRST

Do not open this question booklet until you are told to do so.

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, class and index number in the spaces provided on the Answer Sheet.

There are **thirty** questions in this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in the question booklet.
The use of an approved scientific calculator is expected, where appropriate.

This document consists of **15** printed pages and **1** blank page.

1 *Use of the Data Booklet is relevant to this question.*

How many molecules are present in 1 cm^3 of methane gas under room temperature and pressure?

A $\frac{6.02 \times 10^{23}}{24000}$

B $\frac{6.02 \times 10^{23}}{22400}$

C $\frac{22400}{6.02 \times 10^{23}}$

D $\frac{24000}{6.02 \times 10^{23}}$

2 When 20 cm^3 of a gaseous hydrocarbon was completely burnt in 130 cm^3 of oxygen in an enclosed vessel, the volume of gas remaining after the reaction was 100 cm^3. This volume was decreased to 40 cm^3 under the same conditions when the resulting mixture was passed through aqueous sodium hydroxide. All gas volumes are measured at room temperature and pressure.

What is the formula of the hydrocarbon?

A C_2H_2 **B** C_3H_6 **C** C_3H_8 **D** C_4H_{10}

3 What do the ions $^{18}O^{2-}$ and $^{19}F^-$ have in common?

A They have more electrons than neutrons.

B They have 10 neutrons in their nuclei.

C They have an outer electronic configuration of $3s^2\ 3p^6$.

D They contain the same number of nucleons in their nuclei.

4 In beta−minus decay, a neutron in the nucleus of an atom is converted into a proton and a beta particle (electron). This increases the atomic number by 1 while the mass number remains unchanged.

Thorium−234, $^{234}_{90}Th$, undergoes beta−minus decay. What is the resulting species after the decay process?

A $^{234}_{89}Ac$ **B** $^{233}_{91}Pa^+$ **C** $^{234}_{91}Pa$ **D** $^{235}_{90}Th^-$

5 Water has a higher boiling point than hydrogen fluoride.

What is the major reason for this?

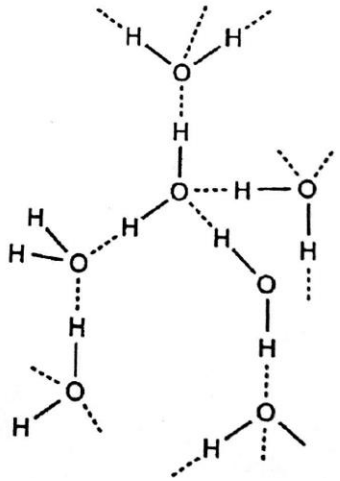
A The O−H bond in water is stronger than the F−H bond in hydrogen fluoride.

B A water molecule contains more electrons than a hydrogen fluoride molecule.

C On average, there are more hydrogen bonds between water molecules than there are between hydrogen fluoride molecules.

D A hydrogen fluoride molecule is more polar than a water molecule.

6 The diagram shows the structure of part of a crystal of ice.



Which statement is correct?

A The open structure of ice causes ice to be denser than water.

B The hydrogen bonds are stronger than the O−H covalent bonds.

C Two electrons from each oxygen are involved in forming hydrogen bonds.

D Each oxygen atom is tetrahedrally bonded to four hydrogen atoms through covalent or hydrogen bonds.

7 Compound E, $C_3H_2Cl_2$, is non-cyclic.

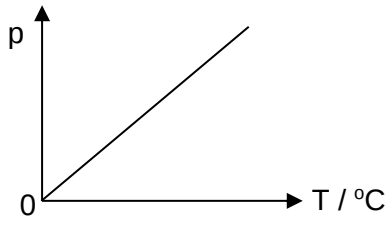
Which statements are correct for E and all its non-cyclic isomers?

1 There are 6 σ and 2 π bonds present.
2 The optically active isomers each contain a chiral carbon.
3 There is a total of five non-cyclic isomers, including stereoisomers.

A 1 and 2 **B** 1 and 3 **C** 2 and 3 **D** 1 only

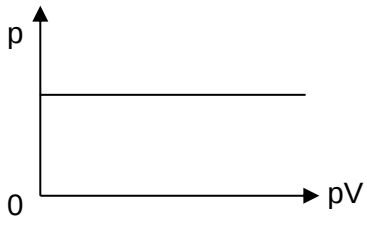
8 Which graph is correct for a fixed mass of an ideal gas?

A



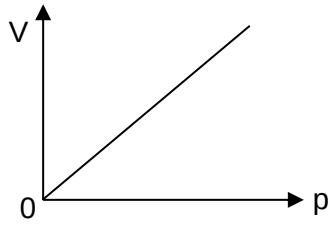
constant V

B



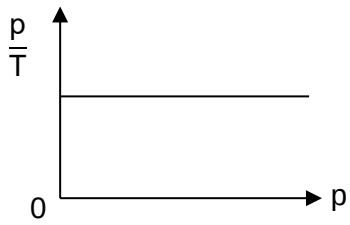
constant T

C



constant T

D



constant V

9 Which row correctly describes the general trends from sodium to chlorine across Period 3 of the Periodic Table?

	atomic radius	electronegativity	1st ionisation energy
A	increases	decreases	decreases
B	decreases	increases	decreases
C	decreases	increases	increases
D	increases	increases	increases

10 Elements L and M are in Period 3 of the Periodic Table.

The oxide of L dissolves sparingly in water. The pH of the solution of the chloride of L is higher than that of the chloride of M.

Which row correctly shows the identities of L and M?

	L	M
A	Mg	A*l*
B	Mg	Na
C	Na	Si
D	Na	S

11 Which property of X_2 increases down the group for X = C*l*, Br or I?

A volatility

B bond length

C bond energy

D oxidising power

12 The standard enthalpy change of the following reaction, $\Delta H_r^{\ominus}$, can be calculated using the data in the table.

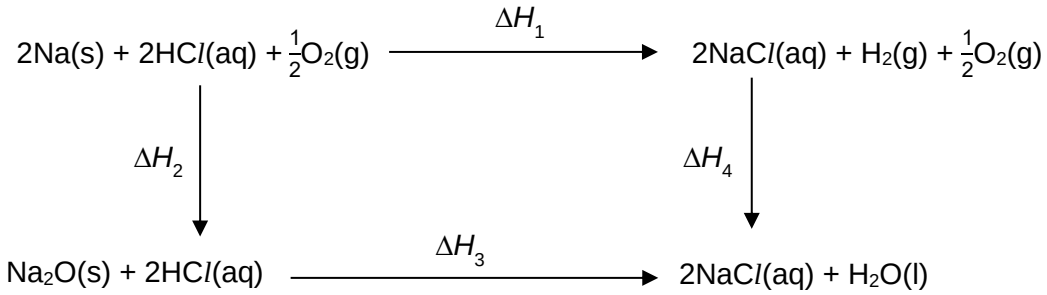
$$2NO(g) + O_2(g) \xrightarrow{\Delta H_r^{\ominus}} N_2O_4(g)$$

equation	$\Delta H^{\ominus}$ / kJ mol^{-1}
$\frac{1}{2}N_2(g) + \frac{1}{2}O_2(g) \longrightarrow NO(g)$	+91
$\frac{1}{2}N_2(g) + O_2(g) \longrightarrow NO_2(g)$	+34
$2NO_2(g) \longrightarrow N_2O_4(g)$	–58

What is the value of $\Delta H_r^{\ominus}$?

A –172 kJ mol^{-1} **B** –115 kJ mol^{-1} **C** –56 kJ mol^{-1} **D** –1 kJ mol^{-1}

13 Hydrochloric acid can react with sodium and sodium oxide to give different products.



Which statement is correct?

A $\Delta H_1 + \Delta H_2$ is always positive.

B $\Delta H_3 + \Delta H_4$ is always positive.

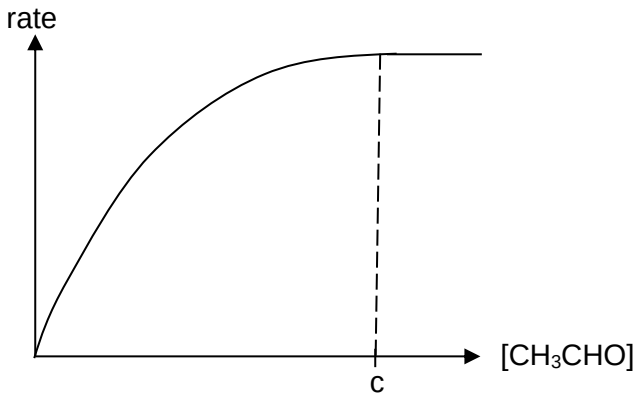
C $\Delta H_3 - \Delta H_4 - \Delta H_1$ is always negative.

D $\Delta H_2 + \Delta H_3 - \Delta H_1$ is always negative.

14 The following reaction is catalysed by an enzyme.

$$CH_3CHO + 2[H] \longrightarrow CH_3CH_2OH$$

The graph shows how the rate of the reaction varies with $[CH_3CHO]$.



Which statement is correct when $[CH_3CHO] = c$?

A There are no more enzyme active sites available.

B The order of reaction with respect to $[CH_3CHO]$ is 1.

C As more CH_3CH_2OH is produced, the reaction slows down.

D All the CH_3CHO has been used up and the reaction stops.

15 X(g) is placed in a sealed vessel and allowed to reach equilibrium at constant temperature.

$$X(g) \rightleftharpoons Y(g)$$

Under the same conditions, which statements are correct?

1 Given that X and Y behave as ideal gases, $K_c = K_p$.

2 $\frac{P_Y}{P_X}$ at equilibrium is the same if Y(g) is used initially instead of X(g).

3 Adding more X(g) causes the partial pressures of both gases to be higher at the new equilibrium.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

16 20.0 cm^3 of 0.100 mol dm^{-3} of dilute nitric acid was titrated against 0.100 mol dm^{-3} of aqueous ammonia.

Which volume of aqueous ammonia is required to produce a buffer with maximum buffering capacity?

A 10.0 cm^3 **B** 20.0 cm^3 **C** 30.0 cm^3 **D** 40.0 cm^3

17 A 1.00 mol dm^{-3} solution of CH_3COO^- was prepared at 50 °C.

K_a for ethanoic acid = 1.63×10^{-5} mol dm^{-3} and pK_w = 13.3 at 50 °C.

What is the pH of this solution at 50 °C?

A 4.26 **B** 9.04 **C** 9.39 **D** 9.74

18 Which substance will cause the formation of a precipitate when added to a saturated solution of magnesium carbonate?

A NaC*l*(s)

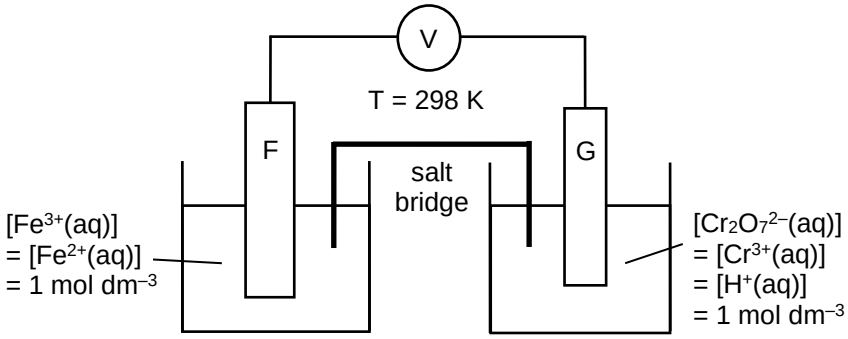
B H_2O(l)

C K_2CO_3(s)

D HC*l*(aq)

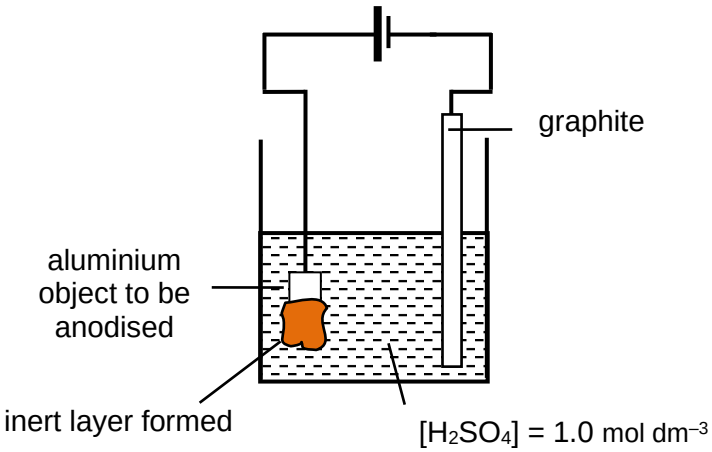
19 *Use of the Data Booklet is relevant to this question.*

Which row gives the standard cell potential on the voltmeter and the correct direction of electron flow in the connecting wire?



	$E^{\ominus}_{cell}$ / V	direction of flow
A	+0.56	F to G
B	+0.56	G to F
C	−0.56	F to G
D	−0.56	G to F

20 The process of coating aluminium objects with an inert layer via electrolysis is called anodising. The set-up used for anodising aluminium is shown.



Which statement is correct?

A The mass of the cathode increases.

B Water is preferentially reduced to form oxygen gas at the anode.

C Water is preferentially reduced to form hydrogen gas at the cathode.

D The gas formed at the anode reacts to form an inert layer on the object to be anodised.

21 Which statement is correct about the properties of both potassium and copper?

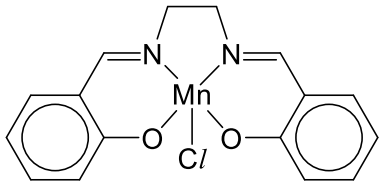
A Both elements have similar density.

B Both elements can form compounds that are white in colour.

C Both elements form stable compounds with the metal having an oxidation state of +2.

D Both elements use electrons from two subshells for metallic bonding.

22 The Mn-salen complex protects cells from oxidative damage and improves the mitochondrial function of neurons.



Which statements regarding the Mn-salen metal complex are correct?

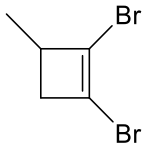
1 The shape about Mn is octahedral.

2 Mn has an oxidation number of +3 in the complex.

3 The complex contains a monodentate ligand and a tetradentate ligand.

A 2 only **B** 3 only **C** 1 and 2 **D** 2 and 3

23 Which statements correctly identify the features of the following compound?



1 It is planar.

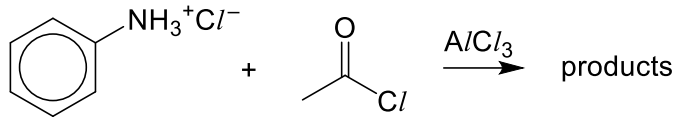
2 It exists as enantiomers.

3 It exists as cis-trans isomers.

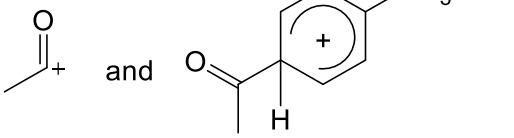
A 1 only **B** 2 only **C** 1 and 3 **D** 2 and 3

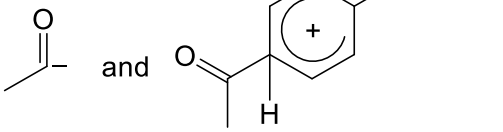
24 *Use of the Data Booklet is relevant to this question.*

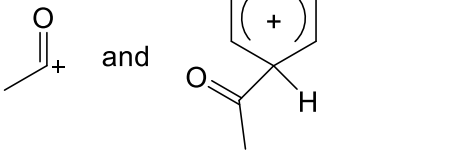
The reaction between phenylammonium chloride and ethanoyl chloride proceeds via several stages with two intermediates.

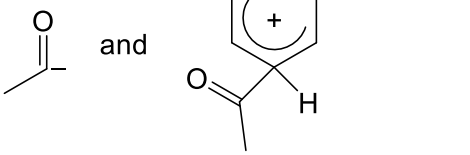


What could be the intermediates formed to produce the major product for this reaction?

A  and

B  and

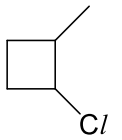
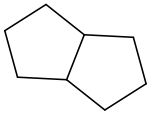
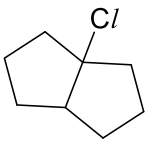
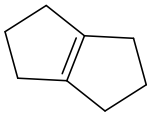
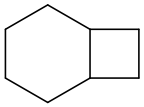
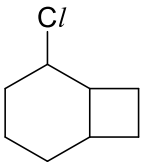
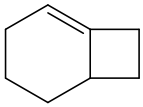
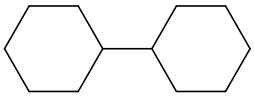
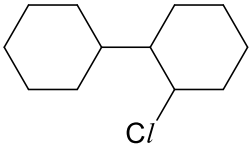
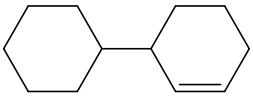
C  and

D  and

25 P reacts with chlorine in the presence of ultraviolet light to produce only four monochlorinated compounds, excluding stereoisomers.

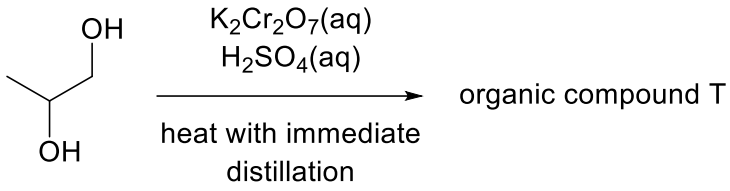
Q, one of the monochlorinated compounds, reacts with hot ethanolic KOH to produce R as a major product.

What are the possible structures of P, Q and R?

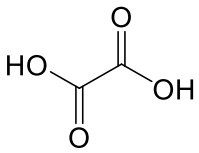
	structure of P	structure of Q	structure of R
1			
2			
3			
4			

A 1 and 2 only **B** 2 and 3 only **C** 1 and 3 only **D** 1, 3 and 4

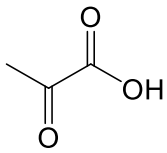
26 What could be the identity of compound T?



A



B



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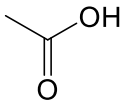
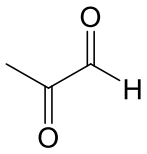
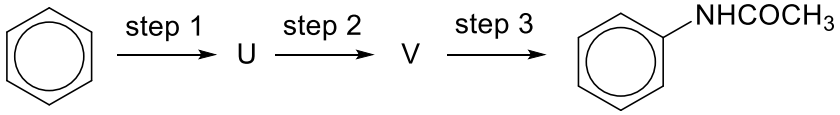


D

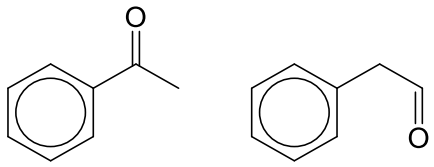


27 Which row shows the correct reagents and conditions for this synthesis?



	step 1	step 2	step 3
A	Br_2, $FeBr_3$	excess NH_3, heat in sealed tube	CH_3COCl
B	conc. HNO_3, H_2SO_4, heat	$LiAlH_4$	CH_3COCl
C	conc. HNO_3, H_2SO_4, heat	Sn, HCl	CH_3COOH, conc. H_2SO_4, heat
D	conc. HNO_3, H_2SO_4, heat	Sn, HCl	CH_3COCl

28 Which reagents and conditions would allow these two compounds to be distinguished from each other?



1 2,4-DNPH

2 Tollens' reagent, heat

3 Fehling's reagent, heat

4 $KMnO_4$, H_2SO_4, heat

A 1 and 2 **B** 2 and 3 **C** 2 and 4 **D** 3 and 4

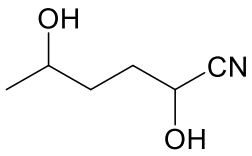
29 J is an organic compound with the formula $C_6H_{11}O_2N$.

It reacts with excess HC*l*(aq) to form a mixture containing the compound with the formula $C_6H_{12}O_2NCl$.

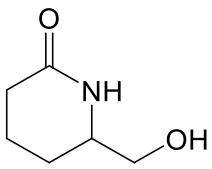
Upon heating this mixture, a product with the formula $C_6H_{14}O_3NCl$ is formed.

What could be the identity of J?

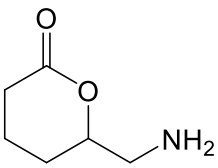
A



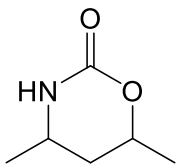
B



C

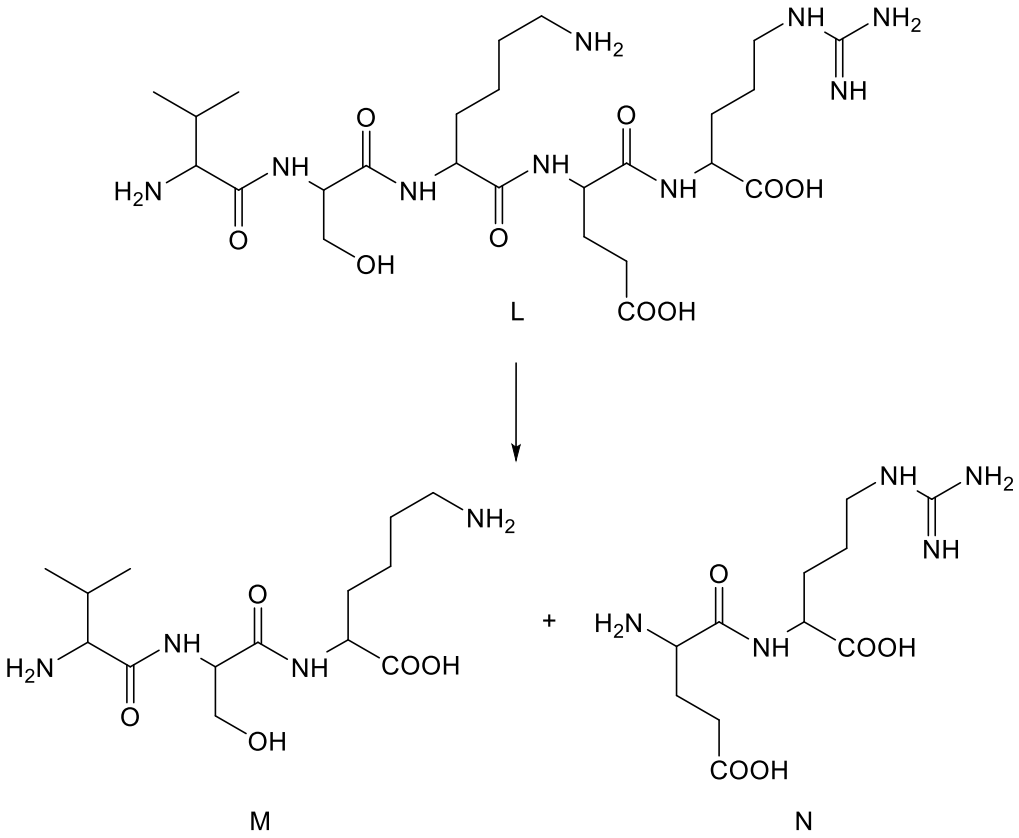


D



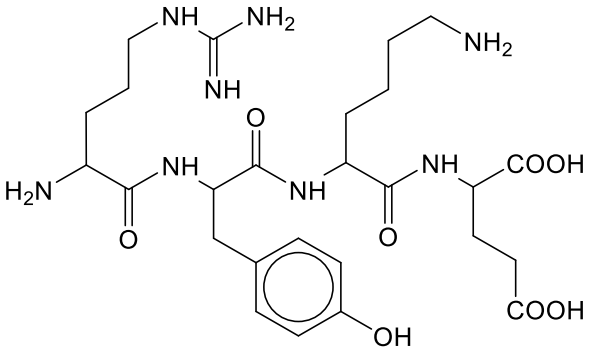
30 Trypsin is an enzyme that hydrolyses proteins into smaller peptides and amino acids. It specifically hydrolyses the peptide bond on the carboxyl side of a residue that contains a positively charged group.

For example, the pentapeptide L produces only two compounds M and N. This is because the $–(CH_2)_4–NH_2$ group on the side chain is basic and can be protonated to a $–(CH_2)_4–NH_3^+$ group.

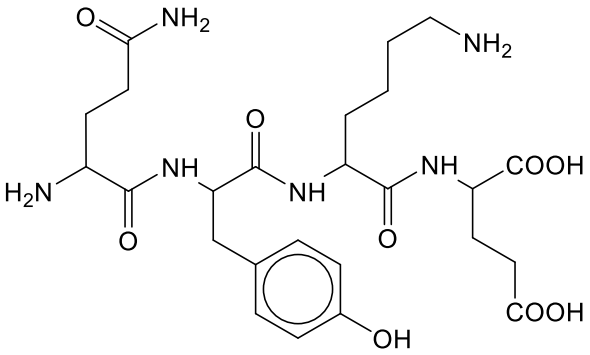


Which tetrapeptide would give 3 different products when hydrolysed by trypsin?

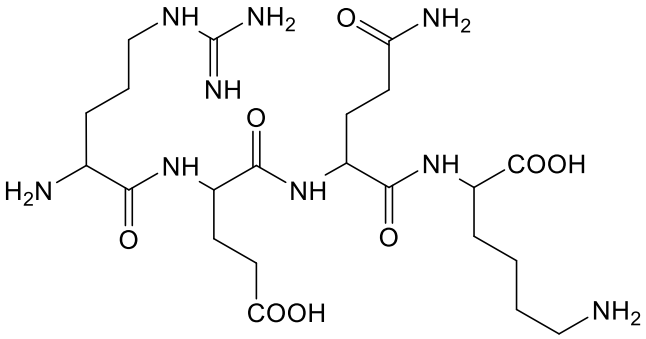
A



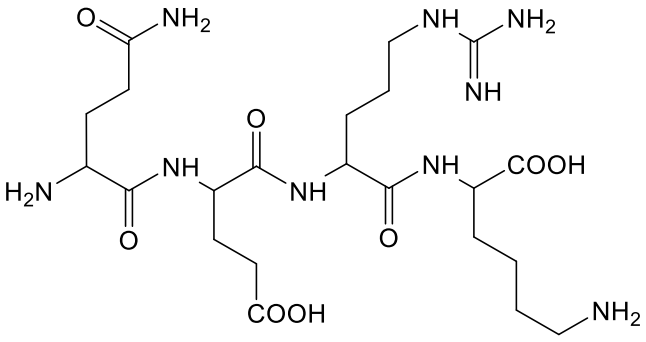
B



C



D



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