Class Adm No

Candidate Name: _____

H

millennia institute

2015 Preliminary Examination II

Pre-university 3

H2 CHEMISTRY **9647/01**

Paper 1 Multiple Choice **23rd Sept 2015**

1 hour

Additional materials: Multiple Choice Answer Sheet
Data Booklet

READ THESE INSTRUCTIONS FIRST

Do not turn over this question paper 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 admission number in the spaces provided at the top of this page and on the Multiple Choice Answer Sheet provided.

There are **forty** questions on 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 Multiple Choice Answer Sheet provided.

Read the instructions on the Multiple Choice 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 this question paper.

The use of an approved scientific calculator is expected, where appropriate.

FOR EXAMINER'S USE	
TOTAL (40 marks)	

Section A

For each question there are four possible answers, **A**, **B**, **C**, and **D**. Choose the **one** you consider to be correct.

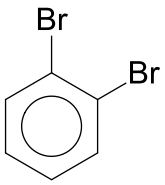
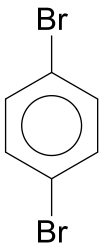
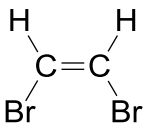
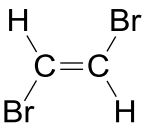
1 On heating, 0.020 mol of the element **M** reacts with 0.020 mol of oxygen gas.
What is the empirical formula of the oxide of **M**?

A **M**O **B** **M**O_2 **C** $\mathbf{M}_2O$ **D** $\mathbf{M}_2O_2$

2 The electronic configuration of four elements are given below.
Which of these elements has the lowest first ionisation energy?

A $1s^2\ 2s^2\ 2p^3$
B $1s^2\ 2s^2\ 2p^4$
C $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3$
D $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4$

3 In which pair of compounds is the permanent dipole moment in Compound **I** smaller than that in Compound **II**?

	Compound **I**	Compound **II**
A	CH_3CH_2Br	CH_3CHBr_2
B	CH_3CH_2F	CH_3CH_2Br
C		
D		

4 Iodine solid has a density of 4.93 g cm^{-3}.

What is the volume of iodine vapour formed when 1 cm^3 of solid iodine at room temperature was heated to 300 °C at a pressure of 1 atm?

A 0.478 dm^3

B 0.912 dm^3

C 0.955 dm^3

D 1.82 dm^3

5 Glucose has the formula $C_6H_{12}O_6$. It undergoes combustion in excess oxygen. Some standard enthalpy change of formation values are given below:

compound	$\Delta H_f^{\ominus}$**/kJ mol^{-1}**
$H_2O(l)$	-286
$CO_2(g)$	-394
$C_6H_{12}O_6(s)$	-1273

Which of the following options correctly describes the signs of $\Delta H^{\ominus}$ and $\Delta S^{\ominus}$ for the combustion reaction of glucose?

	$\Delta H^{\ominus}$	$\Delta S^{\ominus}$
A	–	–
B	–	+
C	+	–
D	+	+

6 During electrolysis using inert electrodes, a large current was passed through a dilute copper(II) sulfate solution.

What are the products formed at the anode and cathode?

	anode	cathode
A	copper metal	sulfur dioxide gas
B	oxygen gas	copper metal
C	$S_2O_8^{2-}$ ions	copper metal
D	sulfur dioxide gas	copper metal

7 Two equilibria are shown below.

$$2AB(g) \rightleftharpoons A_2(g) + B_2(g) \qquad \textbf{reaction 1}$$

$$\tfrac{1}{2}A_2(g) + \tfrac{1}{2}B_2(g) \rightleftharpoons AB(g) \qquad \textbf{reaction 2}$$

The numerical value of K_c for **reaction 1** is 4. Under the same conditions, what is the numerical value of K_c for **reaction 2**?

A $\frac{1}{4}$ **B** $\frac{1}{2}$ **C** 2 **D** 4

8 The following equation shows the dissociation of water at 298 K.

$$H_2O(l) \rightleftharpoons H^+(aq) + OH^-(aq) \qquad \Delta H > 0$$

The ionic product of water is defined by the following expression at 298 K.

$$[H^+][OH^-] = 1.0 \times 10^{-14}\ mol^2\ dm^{-6}$$

Which of the following can be deduced from these data?

A When water is cooled only the concentration of $H^+(aq)$ increases.

B When water is cooled the concentration of both $H^+(aq)$ and $OH^-(aq)$ increases.

C Water is alkaline at temperatures below 298 K.

D The pH of water at temperatures below 298 K is greater than 7.

9 The value of solubility product, K_{sp}, of silver ethanedioate, $Ag_2C_2O_4$, at 298 K is 6.10×10^{-12}. What is the concentration of Ag^+ in a saturated solution of $Ag_2C_2O_4$ at 298 K?

A 1.23×10^{-6} mol dm^{-3}
B 2.47×10^{-6} mol dm^{-3}
C 1.15×10^{-4} mol dm^{-3}
D 2.30×10^{-4} mol dm^{-3}

10 The rate of reaction between bromine and methanoic acid is first order with respect to both bromine and to methanoic acid.

$$Br_2(aq) + HCOOH(aq) \rightarrow 2Br^-(aq) + 2H^+(aq) + CO_2(g)$$

Which of the following statements about the reaction above is true?

A The unit for the rate constant is mol dm^{-3} s^{-1}.
B The overall order of the reaction is one.
C Halving the concentration of bromine halves the rate of evolution of gas.
D Doubling the concentration of methanoic acid will not affect the rate of reaction.

11 At a crime scene, some samples of fibres were collected from the victim and sent to the forensic laboratory. Upon analysis, the fibres were found to contain an oxide of **E** and a chloride of **G**.

E and **G** are elements of Period 3 and the following are known:

- Oxide of **E** has a very high melting point and it does not dissolve in water. It is a good conductor of electricity in molten state.
- Chloride of **G** has a low melting point and it dissolves readily in water to give a solution which turns blue litmus paper red. It is a non-conductor of electricity.

What are the possible identities of the two fibres?

	Oxide of **E**	Chloride of **G**
A	Al_2O_3	$SiCl_4$
B	Al_2O_3	$MgCl_2$
C	Na_2O	PCl_3
D	SiO_2	$NaCl$

12 A mixture of the oxides of two elements in Period 3 is dissolved in water. The resultant solution is acidic.

What could be the constituents of the mixture?

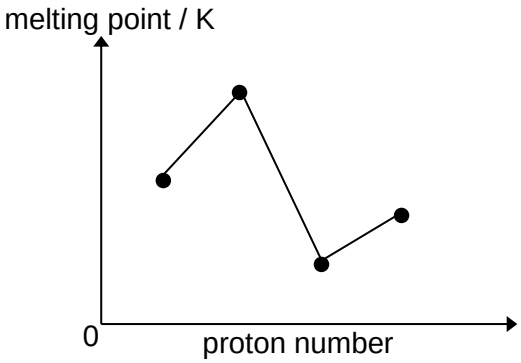
A MgO and Al_2O_3

B Na_2O and MgO

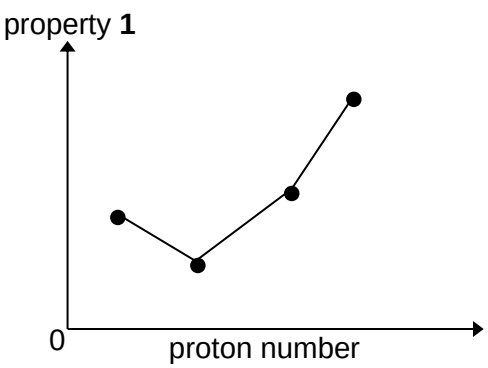
C Na_2O and SiO_2

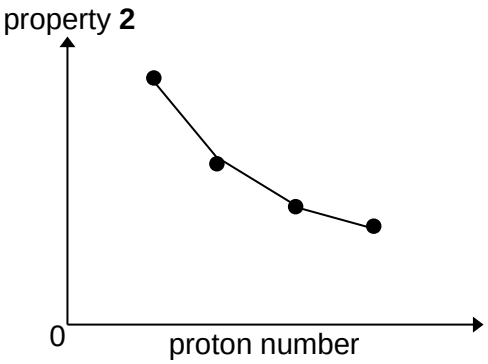
D P_4O_{10} and SO_2

13 The diagram below represents the melting points of four consecutive elements in Period 3 of the Periodic Table.



The sketches below represent another two properties of the same elements.





What are properties **1** and **2**?

	Property **1**	Property **2**
A	first ionisation energy	atomic radius
B	electrical conductivity	electronegativity
C	second ionisation energy	atomic radius
D	electrical conductivity	first ionisation energy

14 Which one of the following statements about Group II elements (magnesium to barium) or their compounds is **incorrect**?

A Reactivity of Group II elements with oxygen increases down the group.
B The stability of the carbonate to heat increases down the group.
C The tendency to form complex ions increases down the group.
D The pH of the aqueous oxides are all above 7.

15 Two separate experiments were carried out with anhydrous potassium bromide.

Experiment 1:
Concentrated sulfuric acid was added to the potassium bromide and heated. The resultant solution was added to potassium iodide solution.

Experiment 2:
The potassium bromide was dissolved in concentrated aqueous ammonia and this was then added to aqueous silver nitrate.

What are the observations for experiment 1 and 2 respectively?

	Observation for experiment 1	**Observation for experiment 2**
A	brown solution	cream precipitate
B	brown solution	no precipitate
C	purple solution	cream precipitate
D	purple solution	no precipitate

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

Vanadium is a transition metal that can form stable coloured ions of various oxidation states in aqueous solutions. Some of the ions of vanadium and their corresponding colours are shown in the table below.

formula of vanadium ion	VO_3^-	VO^{2+}	V^{3+}	V^{2+}
colour of aqueous solution	yellow	blue	green	violet

What is the final colour of the solution when excess lead metal is added to an acidified solution of VO^{2+}?

A blue **B** green **C** violet **D** yellow

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

Aqueous chlorine solution is added to a test-tube containing aqueous Fe^{2+} ions. Aqueous sodium hydroxide is then added dropwise to the test-tube until in excess.

Which process does **not** occur in this series of tests?

A formation of a complex ion

B oxidation of Fe^{2+} ions

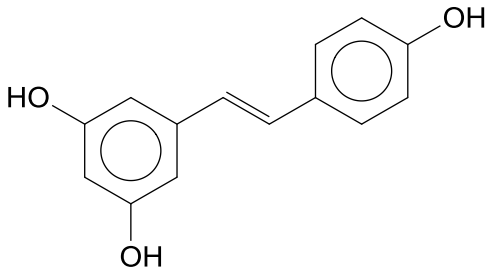
C precipitation of iron(III) hydroxide

D formation of chloride ions

18 Which of the following species is **not** a possible intermediate in the reaction between methane and limited chlorine in the presence of UV light?

A $Cl\bullet$ **B** $\bullet CH_3$ **C** $\bullet CH_2Cl$ **D** $H\bullet$

19 Resveratrol is a type of natural phenol which can be found in the skin of grapes and berries.



Resveratrol

Which of the following statements about resveratrol is **false**?

A It reacts with both oxidising and reducing agents.

B It displays geometric isomerism.

C It is attacked by electrophiles and nucleophiles.

D All the carbon atoms are sp^2 hybridised.

20 Hydrogen bromide undergoes addition reaction with 1-butene forming 2-bromobutane as the major product. When 1-butene is bubbled through chlorine monobromide, C*l*Br, dissolved in a suitable solvent, a similar reaction takes place.

Which of the following gives the structure of the major product formed?

A $CH_3CH_2\underset{\underset{Cl}{|}}{C}HCH_2Cl$

B $CH_3CH_2\underset{\underset{Br}{|}}{C}HCH_2Cl$

C $CH_3CH_2\underset{\underset{Br}{|}}{C}HCH_2Br$

D $CH_3CH_2\underset{\underset{Cl}{|}}{C}HCH_2Br$

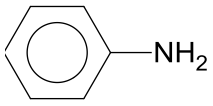
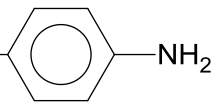
21 Benzene reacts with chloromethane in the presence of anhydrous iron(III) chloride.
What is the role of iron(III) chloride?

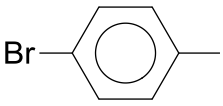
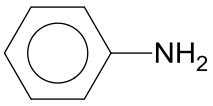
A To generate chloride ions.
B To generate free radicals.
C To generate electrophiles.
D To generate nucleophiles.

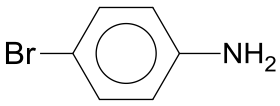
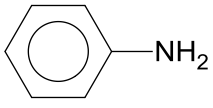
22 Which of the following sequences shows the correct order of increasing ease of hydrolysis?

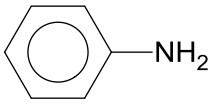
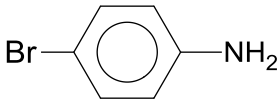
A CH_3CH_2COCl, C_6H_5Cl, $CH_3CH_2CH_2Br$, $CH_3CH_2CH_2Cl$
B CH_3CH_2COCl, $CH_3CH_2CH_2Br$, $CH_3CH_2CH_2Cl$, C_6H_5Cl
C C_6H_5Cl, $CH_3CH_2CH_2Cl$, $CH_3CH_2CH_2Br$, CH_3CH_2COCl
D C_6H_5Cl, $CH_3CH_2CH_2Br$, $CH_3CH_2CH_2Cl$, CH_3CH_2COCl

23 In which of the following series are the compounds arranged in order of increasing pK_b values?

A CH_3NH_2 ,  , 

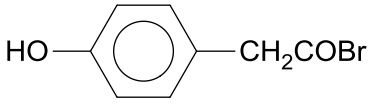
B CH_3NH_2 ,  , 

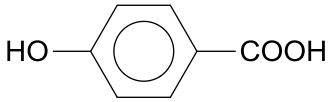
C  ,  , CH_3NH_2

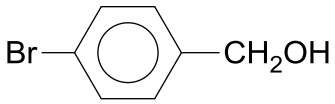
D  , CH_3NH_2 , 

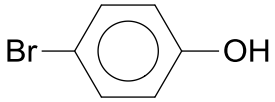
24 Compound **T** when added to water does not undergo any vigorous reaction. It does not readily react with aqueous sodium hydroxide.

What could Compound **T** be?

A 

B 

C 

D 

25 An organic compound **U**, $C_6H_{12}O_2$, is refluxed with aqueous sulfuric acid. The products are organic liquids **V**, $C_3H_6O_2$ and **W**, C_3H_8O. When **W** is warmed with alkaline iodine, a yellow precipitate is obtained.

Which is the structure of **U**?

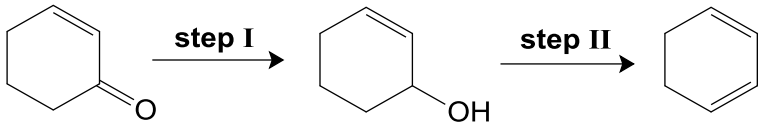
A $CH_3COOC(CH_3)_3$

B $(CH_3)_2CHCOOCH_2CH_3$

C $CH_3CH_2COOCH_2CH_2CH_3$

D $CH_3CH_2COOCH(CH_3)_2$

26 The following reaction pathway shows the conversion of 2-cyclohexenone to 1,3-cyclohexadiene.

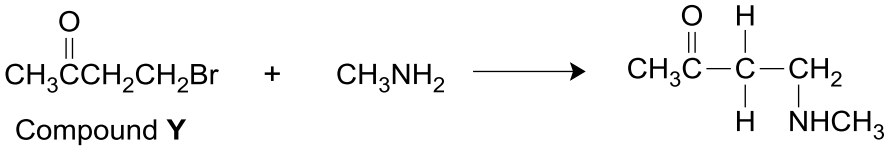


2-cyclohexenone 1,3-cyclohexadiene

Which of the following shows the correct reagents and conditions for the synthesis?

	step I	**step II**
A	$LiAlH_4$ in dry ether	conc H_2SO_4, 180 °C
B	$LiAlH_4$ in dry ether	ethanolic KOH, heat
C	H_2 with Ni catalyst, heat	conc H_2SO_4, 180 °C
D	ethanolic KOH, heat	aqueous KOH, heat

27 Compound **Y** reacts with methylamine as shown below.



Compound **Y**

Which of the following statements about the above reaction is correct?

A Methylamine acts as a nucleophile in the reaction.

B Ammonia gas is released when the product is heated with H_2SO_4(aq).

C Boiling point of compound **Y** is higher than that of the product.

D The reaction is an electrophilic substitution reaction.

28 Compound **Z** is an organic substance which gives the following observations.

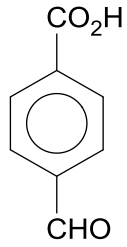
- decolourises hot, acidified $KMnO_4(aq)$
- gives a salt when reacted with $Na_2CO_3(aq)$
- gives a brick red precipitate with Fehling's reagent

What could compound **Z** be?

A $CHOC(CH_3)(OH)CO_2H$

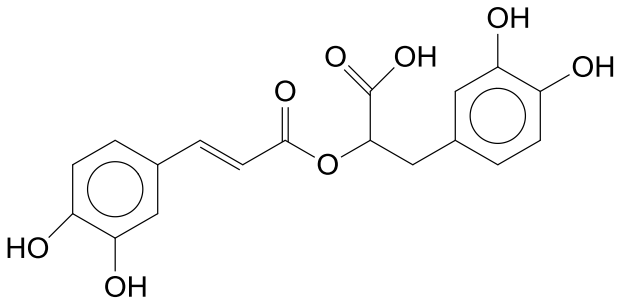
B $CH_2(OH)COCH_2CO_2H$

C



D $CH_2CHCOCH_2CO_2H$

29 Rosmarinic acid is an organic compound found in herbs such as rosemary, sage and thyme.

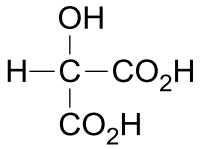


Rosmarinic acid

How many moles of NaOH(aq) will react with one mole of rosmarinic acid at room temperature and heated under reflux respectively?

	at room temperature	**heat under reflux**
A	1	2
B	4	5
C	5	5
D	5	6

30 Malic acid is found in apples.



Malic acid

Which of the following statements about malic acid is correct?

A 1 mole of malic acid reacts with excess sodium metal to give 3 moles of hydrogen gas.

B 1 mole of malic acid reacts with excess sodium carbonate to give 24 dm^3 of carbon dioxide gas at r.t.p.

C 1 mole of malic acid reacts with 3 moles of HBr.

D Malic acid forms a sweet smelling compound when reacted with phenol.

Section B

For each of the questions in this section, one or more of the three numbered statements **1** to **3** may be correct.

Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements that you consider to be correct).

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, **2** and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

31 10 cm^3 of gaseous organic compound, **Q**, was burnt in excess oxygen. 30 cm^3 of carbon dioxide and 5 cm^3 of nitrogen were among the products obtained. All gas volumes were measured at the same temperature and pressure.

Which of the following could be the molecular formulae of **Q**?

1 C_3H_5N

2 $C_3H_8N_2$

3 C_6H_7N

32 Which of the following particles would, on gaining an electron, have a half-filled p orbital?

1 C

2 O^{2+}

3 N^-

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, **2** and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

33 A 0.10 mol dm^{-3} sodium manganate(VII) in alkaline solution was reacted with 0.05 mol dm^{-3} sodium methanoate solution.

$$2NaMnO_4 + 3NaOH + HCOONa \rightarrow 2Na_2MnO_4 + Na_2CO_3 + 2H_2O$$

Which of the following statements about this reaction are **false**?

1 Sodium manganate(VII) acts as a reducing agent.

2 The oxidation state of carbon is decreased by two.

3 The volume of aqueous sodium methanoate solution required is half that of aqueous sodium manganate(VII).

34 Which of the following are linear molecules?

1 HCN

2 ICl_2^-

3 SO_2

35 What factors contribute to the lattice energy of magnesium oxide being more exothermic than that of sodium chloride?

1 The interionic distance in NaCl is larger than that in MgO.

2 The charge on the magnesium ion is greater than that of the sodium ion.

3 Oxygen is more electronegative than chlorine.

36 The equilibrium constant K_c for the reaction

$$\mathbf{P}(aq) + \mathbf{Q}(aq) \rightleftharpoons \mathbf{R}(aq) + H_2O(l)$$

was determined at various temperatures.

Temperature/K	K_c value
298	0.160
318	0.160
338	0.160

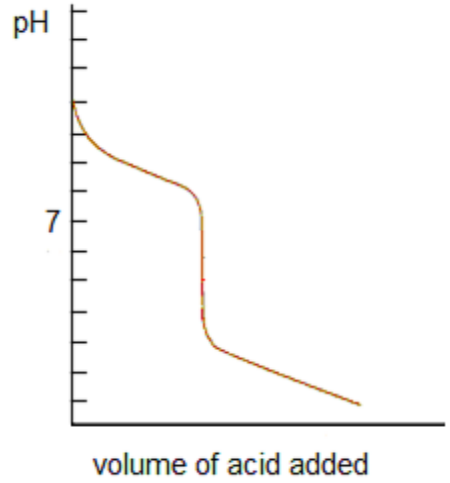
Which of the following could be deduced from the above data?

1 The enthalpy change of reaction is zero.

2 The activation energy for the forward and backward reactions are the same.

3 The units for K_c are $mol^{-1}\ dm^3$.

37 A titration curve is shown below.



Which of the following pairs of reagents could give the titration curve shown?

1 $NH_3(aq)$ and $H_2SO_4(aq)$

2 $CH_3COO^-(aq)$ and $HCl(aq)$

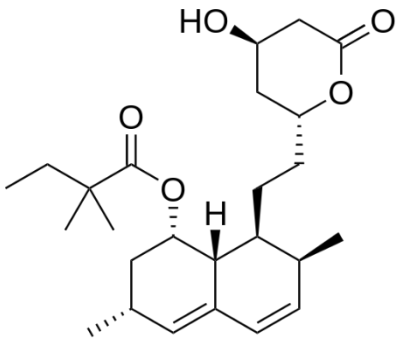
3 $NaOH(aq)$ and $H_2SO_4(aq)$

The responses **A** to **D** should be selected on the basis of

A	B	C	D
1, **2** and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

38 Statins are a class of drugs that lower the level of cholesterol in the blood by reducing the production of cholesterol by the liver. Simvastatin is an example of statin.



Simvastatin

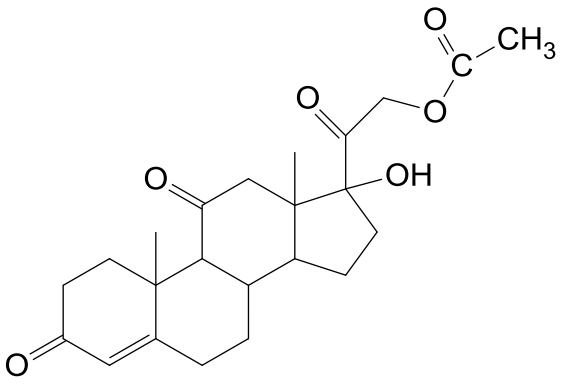
Which statements about the simvastatin molecule are correct?

1 It contains two ketone groups.

2 It contains one secondary alcohol group.

3 It contains 7 chiral centres.

39 Cortisone acetate is used as an active ingredient in anti-inflammatory skin creams.



Cortisone acetate

Which of the following statements are correct?

1 When treated with an excess of hot acidified $K_2Cr_2O_7$, a compound with 3 carbonyl groups is produced.

2 When treated with an excess of hot concentrated acidified $KMnO_4$, ethanoic acid and another compound with 1 carboxylic acid group is produced.

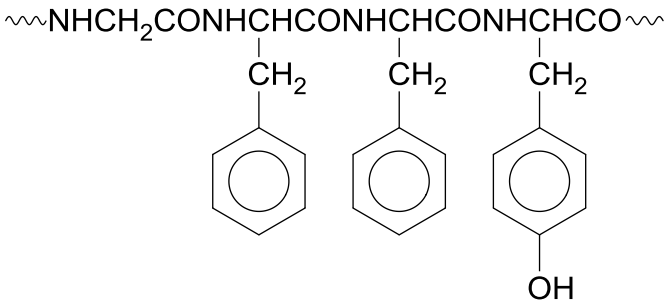
3 The cortisone acetate molecule has a total of 2^7 stereoisomers.

The responses **A** to **D** should be selected on the basis of

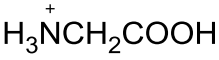
A	B	C	D
1, **2** and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

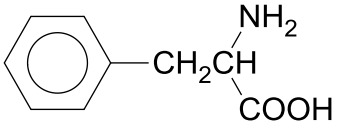
No other combination of statements is used as a correct response.

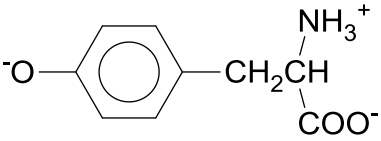
40 Part of the amino acid chain in the insulin of beef is shown below.



When this segment of the amino acid chain is heated in 6 mol dm^{-3} HC*l* for a prolonged period, which of the following products could be obtained?

1 

2 

3 

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