Name _____ **Class:** _____ **Reg Number:** _____

MERIDIAN JUNIOR COLLEGE
JC 2 Preliminary Examination (ANSWERS ON THE LAST PAGE)
Higher 2

Chemistry 9647

Paper 1 Multiple Choice **26 September 2013**

1 hour

Additional Materials: *OMR Sheet*
Data Booklet

INSTRUCTIONS TO CANDIDATES

Write your name, class and register number in the spaces provided at the top of this page.

There are **forty** questions in this section. Answer **all** questions. For each question, there are four possible answers labelled **A**, **B**, **C** and **D**. Choose the **one** you consider correct and record your choice in soft pencil on the OMR answer sheet.

Read very carefully the instructions on the use of OMR answer sheet.

You are advised to fill in the OMR Answer Sheet as you go along; no additional time will be given for the transfer of answers once the examination has ended.

Use of OMR Answer Sheet

Ensure you have written your name, class register number and class on the OMR Answer Sheet.

Use a **2B** pencil to shade your answers on the OMR sheet; erase any mistake cleanly. Multiple shaded answers to a question will not be accepted.

For shading of class register number on the ***OMR sheet***, please follow the given examples:
If your register number is **1**, then shade **01** in the index number column.
If your register number is **21**, then shade **21** in the index number column.

This document consists of **24** printed pages and **1** blank page.

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Section A

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

1 The polyoxometallate $W_{72}Mn_{12}Si_7O_{268}^{40-}$ was recently identified in a crystal garden.

Which row gives oxidation states of tungsten and manganese that are consistent with this formula?

	oxidation state of tungsten	oxidation state of manganese
A	+3	+2
B	+3	+3
C	+6	+2
D	+6	+3

2 During the 1950s, a Sydney woman killed three family members and a friend by putting rat poison into the food and drinks she gave them. The crystalline toxic white compound, thallium sulfate, Tl_2SO_4, is water soluble. A single dose of more than 500 mg is fatal.

At what minimum concentration of thallium sulfate does a 200 cm^3 cup of tea provide a fatal amount of the poison?

A 0.990×10^{-3} mol dm^{-3}

B 1.66×10^{-3} mol dm^{-3}

C 4.96×10^{-3} mol dm^{-3}

D 8.32×10^{-3} mol dm^{-3}

3 Which compound is composed of a cation and anion(s) that do **not** contain the same number of electrons as each other?

A LiH

B NaOH

C NH_4F

D $TiCl_3$

4 Which transition metal ion in the following species has only one unpaired electron in its d orbitals?

A $[CoCl_4]^{2-}$

B $[Fe(H_2O)_5(F)]^{2+}$

C $[Mn(CN)_6]^{3-}$

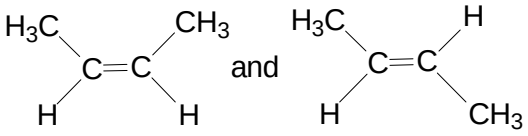
D $[VO(H_2O)_5]^{2+}$

5 In which of the following pairs of compounds is the first member more volatile than the second?

A $CH_3CH_2CH_2CH_3$ and $CH_3CH(CH_3)CH_3$

B CH_3CH_2OH and CH_3OCH_3

C CH_3CH_2COOH and $CH_3CH(NH_2)COOH$

D 

6 A vessel containing ammonia gas is heated to a constant temperature such that the equilibrium below is established.

$$2NH_3(g) \rightleftharpoons N_2(g) + 3H_2(g)$$

The value of the pressure p is then found to be 35% greater than if only $NH_3(g)$ were present.

What is the mole fraction, x, of nitrogen present in this equilibrium mixture?

A 0.130

B 0.175

C 0.389

D 0.611

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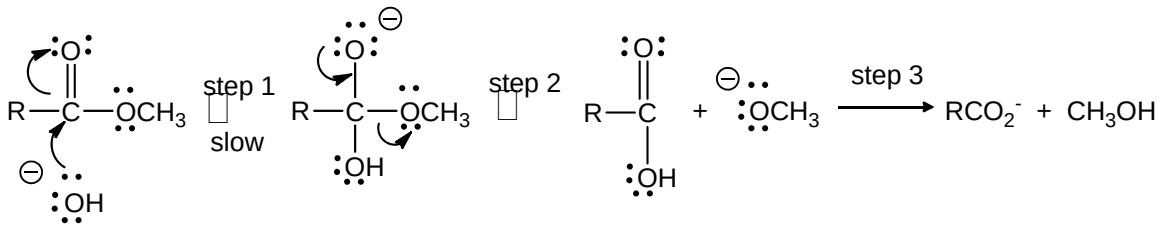
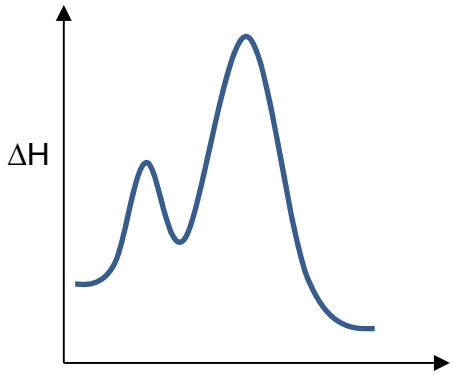
[Turn over

7 The base catalysed hydrolysis of a methyl ester has the following reaction path.

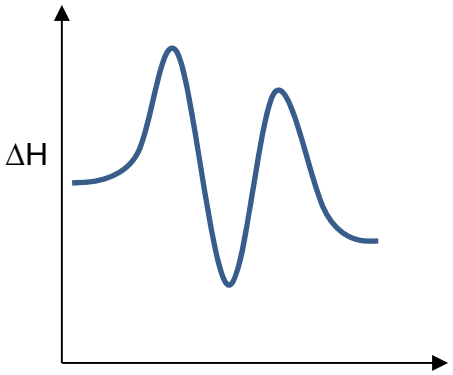


What will be the reaction pathway diagram for the first **two** steps of this hydrolysis?

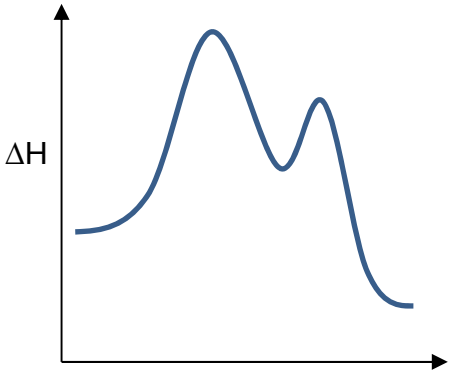
A



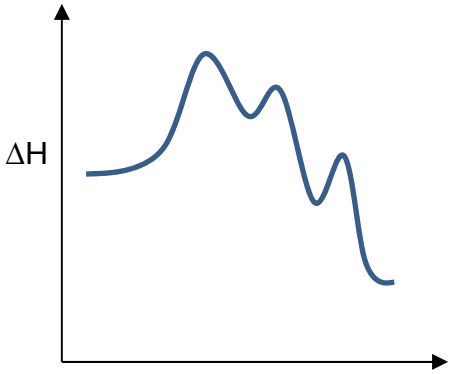
B



C



D



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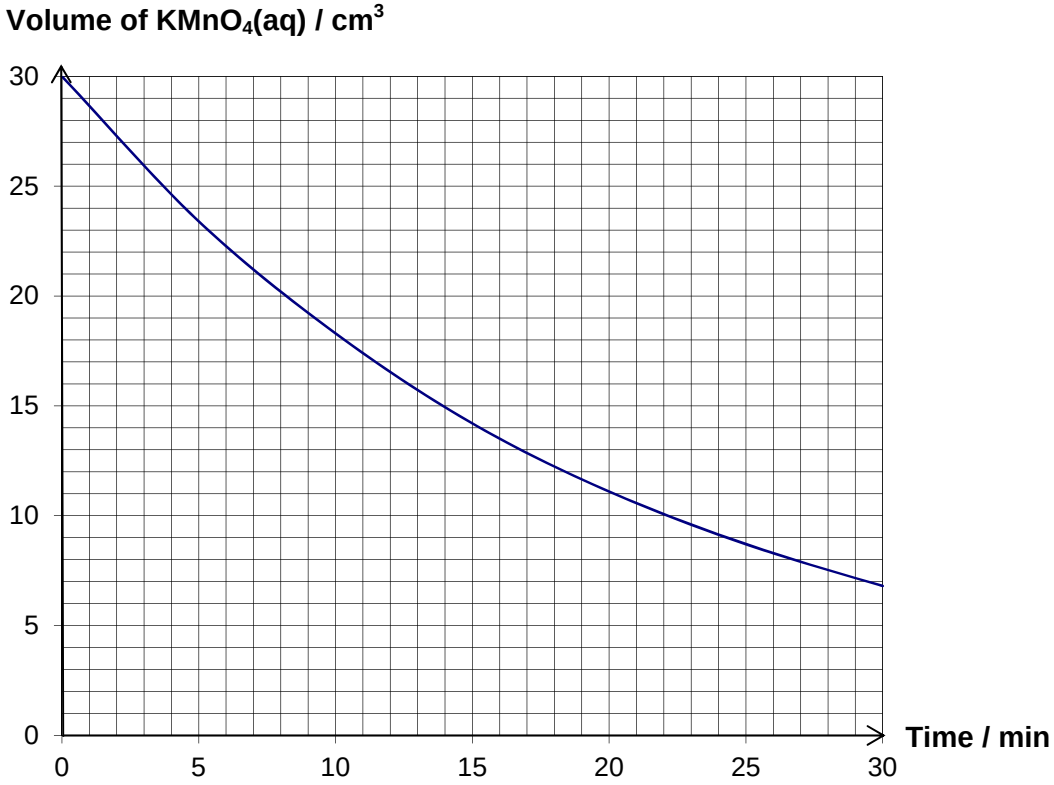
8 A dilute solution of hydrogen peroxide decomposes slowly in aqueous solution according to the following equation:

$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$$

A solution with an original concentration of 3.00 mol dm^{-3} was placed in a bottle contaminated with transition metal ions, which act as catalyst for the decomposition. The rate of decomposition was measured by withdrawing 10.0 cm^3 portion at various times and titrating with acidified 0.05 mol dm^{-3} $KMnO_4(aq)$.

The following results were obtained.



How long has the solution in the bottle been contaminated before the first portion was withdrawn for titration? Assume that 5 mol of H_2O_2 reacts with 2 mol of $KMnO_4$.

A 14 minutes

B 42 minutes

C 84 minutes

D 112 minutes

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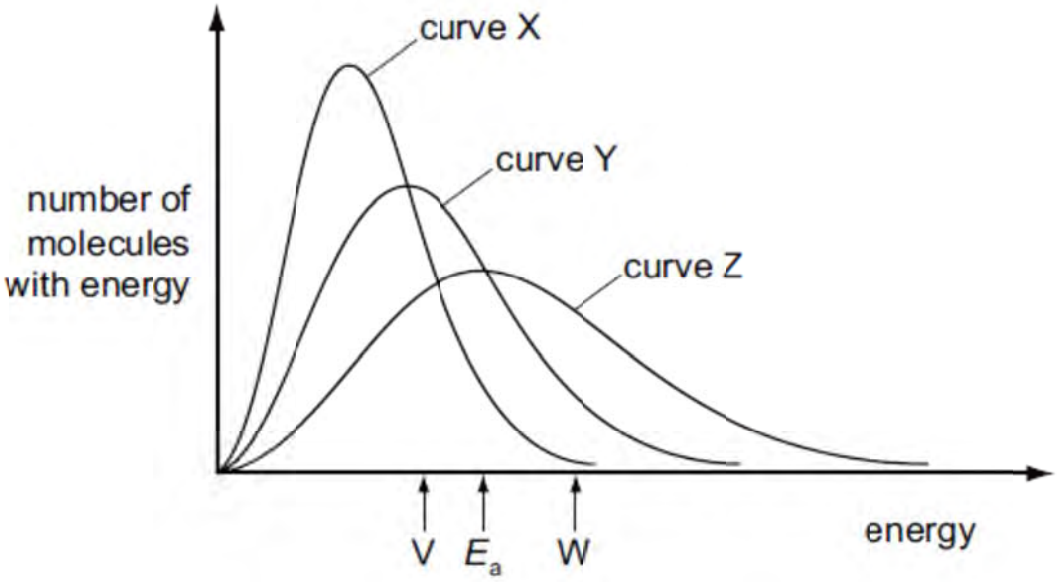
[Turn over

9 The curve **Y** and the value E_a represent the distribution of energies of the molecules and the activation energy for an uncatalysed gaseous reaction.



Which is a possible outcome if the reaction is catalysed?

A The distribution of energies will be given by curve **X** and the activation energy by value **V**.

B The distribution of energies will be given by curve **Y** and the activation energy by value **V**.

C The distribution of energies will be given by curve **Y** and the activation energy by value **W**.

D The distribution of energies will be given by curve **Z** and the activation energy by value **W**.

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10 Citric acid is a weak monobasic acid. Which of the following pair of solutions, when mixed in equal volumes, will give the best buffer solution that resists pH changes when a small amount of acid or base is added?

A 0.5 mol dm^{-3} of citric acid and 0.5 mol dm^{-3} of sodium hydroxide

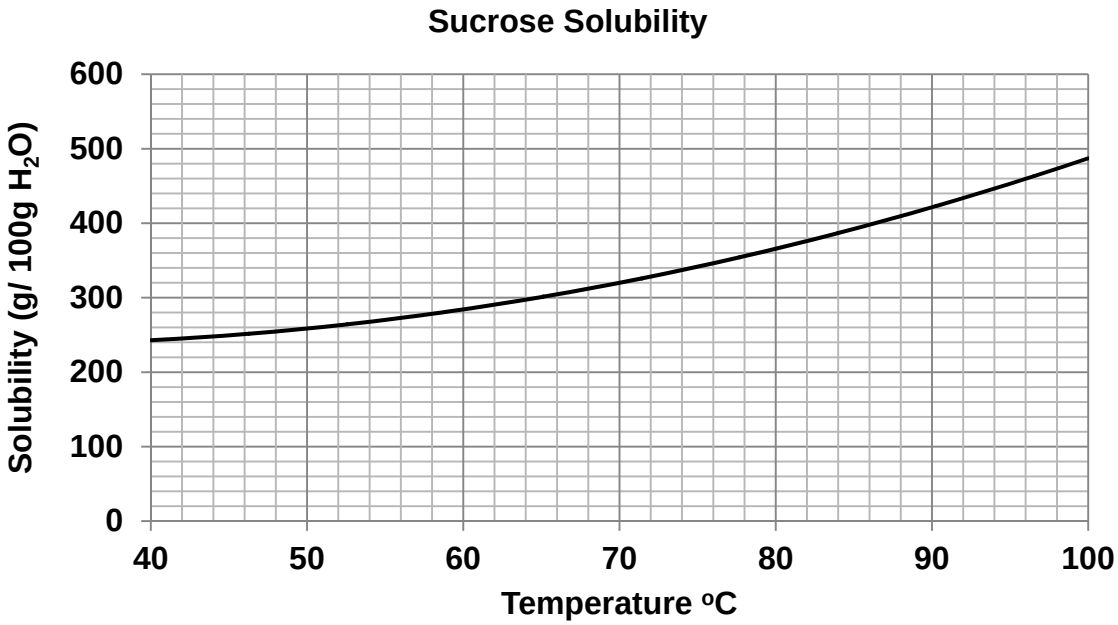
B 0.5 mol dm^{-3} of citric acid and 0.125 mol dm^{-3} of barium hydroxide

C 1.0 mol dm^{-3} of sodium citrate and 0.25 mol dm^{-3} of sulfuric acid

D 1.0 mol dm^{-3} of sodium citrate and 0.5 mol dm^{-3} of citric acid

11 Sucrose, commonly called table sugar is highly soluble, as shown in the graph, and it dissolves according to

$$C_{12}H_{22}O_{11}(s) \rightleftharpoons C_{12}H_{22}O_{11}(aq) \qquad \Delta H = +4.75 \text{ kJ mol}^{-1}$$



A cup of coffee was made with 200 ml of water at 80°C and as much sugar as would dissolve. It was left to cool to 60°C.

During cooling from 80°C to 60°C

A the fraction of $[C_{12}H_{22}O_{11}(aq)]/[C_{12}H_{22}O_{11}(s)]$ remains unchanged.

B the system responds to the change in temperature by absorbing more heat.

C the rate of forward reaction increases as the system can release heat more easily.

D the position of equilibrium moves left as the rate of the reverse reaction is greater than that of the forward reaction.

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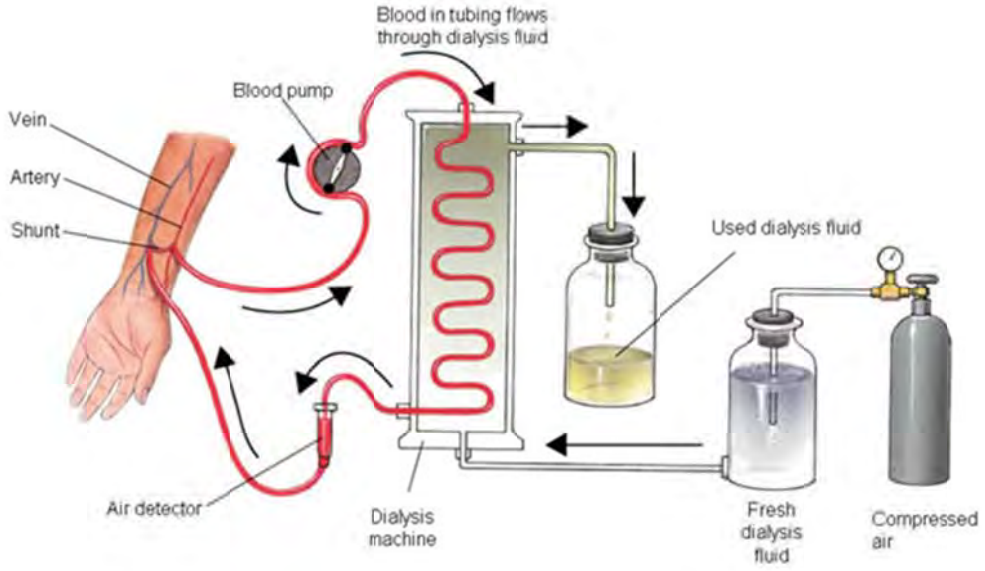
[Turn over

12 Artificial kidney dialysis, such as hemodialysis is used to treat patients suffering from kidney failure. During hemodialysis, a semi-permeable membrane is used to allow waste materials to pass from the blood to the dialysis fluid.

The figure below shows a typical hemodialysis set up.



What are the correct signs of ΔS for blood and dialysis fluid during the hemodialysis process?

	blood	dialysis fluid
A	–	+
B	–	–
C	+	–
D	+	+

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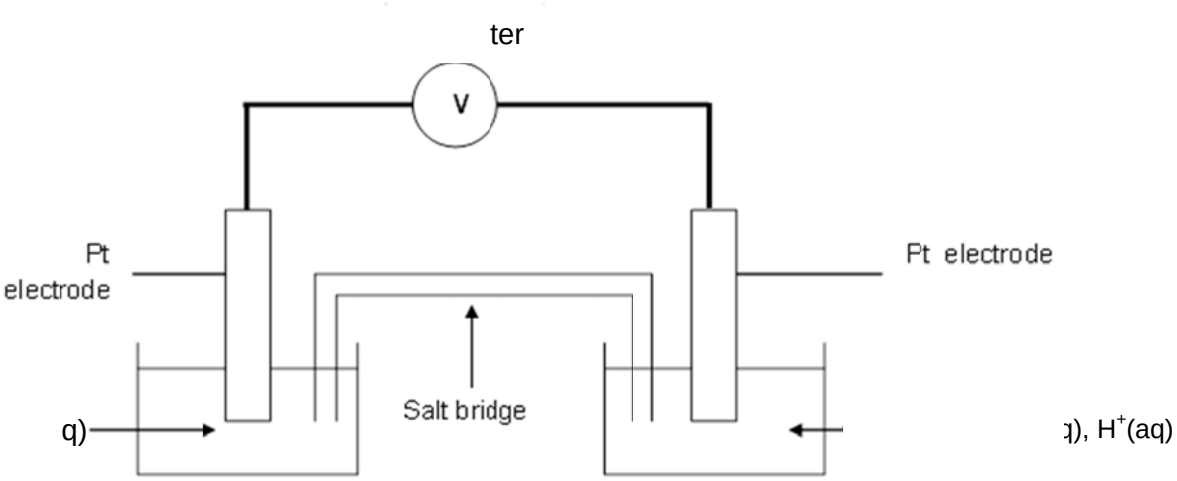
[Turn over

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

If iron is heated separately with chlorine, bromine and iodine, what are the likely products?

	chlorine	bromine	iodine
A	$FeCl_2$	$FeBr_2$	FeI_2
B	$FeCl_3$	$FeBr_2$	FeI_2
C	$FeCl_3$	$FeBr_3$	FeI_2
D	$FeCl_3$	$FeBr_3$	FeI_3

14 A student set up the cell as shown



The following values for the cell potential were determined as a change was continuously made.

reading number	cell potential /V
1	0.1900
2	0.1890
3	0.1878
4	0.1865
5	0.1850

Which continuous change in the MnO_4^- half-cell could produce these results?

A adding a reagent to the solution that complexes with Mn^{2+} (aq)

B increasing the concentration of Mn^{2+}(aq)

C changing the electrode to Mn metal

D adding more acid to the solution

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[Turn over

15 Which of the following statement is correct for the sequence of compounds below considered from left to right?

NaF MgO A*l*N SiC

A The bonding becomes decreasingly covalent.

B The formula-units of these compounds are not isoelectronic.

C Electronegativity difference between the elements in each compound decreases.

D When water is added to these compounds, the resultant solution becomes increasingly acidic.

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

Finely divided solid particles found in reservoirs water have negative charges on their surface which can be easily precipitated. It was found that compound **Y** is very effective in precipitating finely divided solid particles

The salt solution of **Y** contains high-charge density cations which can neutralise the negative charges on the solid particles and cause the solid to coagulate.

Which of the following could be compound **Y**?

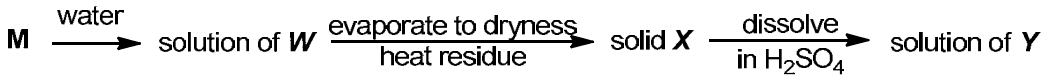
A $FeCl_3$

B $MgCl_2$

C $SiCl_4$

D VCl_3

17 **M** is a Group II metal which can undergo two reaction routes.



Which set contains three different compounds?

A ***P*** ***Q*** ***Y***

B ***P*** ***R*** ***X***

C ***Q*** ***W*** ***Y***

D ***R*** ***W*** ***X***

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[Turn over

18 Which of the following observations about bromine or its compounds is **false**?

A The solubility of silver bromide in aqueous ammonia increases on the addition of a small amount of potassium cyanide solution.

B When aqueous sodium iodide is added to aqueous bromine followed by the addition of CCl_4, a faint brown aqueous layer and a purple organic layer is formed.

C When cold potassium hydroxide is added to bromine, the orange solution is decolourised.

D When potassium bromide is treated with concentrated sulfuric acid, the only gas evolved is one that bleaches moist blue litmus paper.

19 In a famous experiment, the German chemist Wöhler heated an inorganic salt and produced urea, $CO(NH_2)_2$, as the **only** product.

The original inorganic salt, on heating with aqueous NaOH, produced a gas which turned damp red litmus paper blue.

What is the formula of the anion in the original inorganic salt?

A CNO^-

B CN^-

C NO_3^-

D NH_2^-

20 The cracking of a single alkane molecule C_nH_{2n+2} produces two hydrocarbon molecules only. Each hydrocarbon product contains the same number of carbon atoms. Each hydrocarbon product has non-cyclic structural isomers of which optical isomers are also present.

What is the minimum value of n?

A 8 **B** 10 **C** 12 **D** 14

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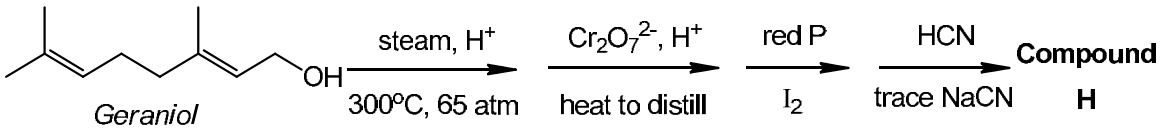
[Turn over

21 *Geraniol* has a rose-like scent and is commonly used in perfumes. It is used in the following synthesis route.

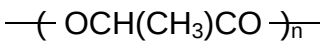


Geraniol

How many sp, sp^2 and sp^3 hybridised carbon atoms are present in compound **H**?

	sp^3	**sp^2**	**sp**
A	11	0	3
B	11	1	2
C	10	1	2
D	10	0	1

22 Poly(lactic acid) (PLA) is a biodegradable polymer used for food packaging and cosmetics bottles. A section of the PLA molecule is shown below.



A sample of PLA was subjected to a series of reactions and the following products were obtained.

Step	Reagent	Organic Product
1	hot NaOH(aq) followed by acidification	Compound **X**
2	hot Al_2O_3	Compound **Y**
3	PCl_5	Compound **Z**

Which of the following statements is true?

A Both compounds **X** and **Y** can exhibit stereoisomerism.

B Compound **X** reacts completely with 2 mol of KOH.

C Compound **Y** reacts with phenol to form a sweet-smelling liquid.

D Compound **Z** reacts with ammonia to form a neutral organic compound.

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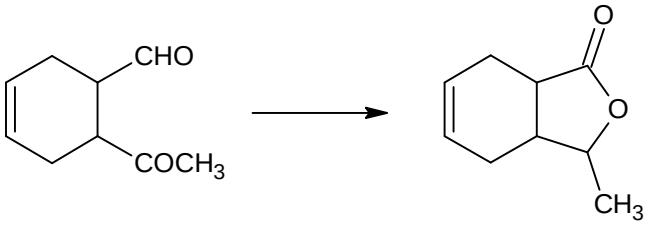
[Turn over

23 Compound **V** can be converted to compound **W** in three stages.



Compound **V** Compound **W**

Which sequence of reagents and conditions can be used to carry out this conversion?

	Stage 1	**Stage 2**	**Stage 3**
A	hot acidified $KMnO_4$	H_2 with Pt catalyst	heat with dilute H_2SO_4
B	hot acidified $K_2Cr_2O_7$	$LiAlH_4$ in dry ether	heat with dilute H_2SO_4
C	hot Fehling's reagent, followed by acidification	$NaBH_4$ in ethanol	heat with a few drops of conc. H_2SO_4
D	hot Tollens' reagent, followed by acidification	$LiAlH_4$ in dry ether	heat with a few drops of conc. H_2SO_4

24 Which reagent reacts with propanal to give an organic product **without** a π bonded carbon atom?

A acidified dichromate (VI) ions

B hydrogen cyanide

C silver diammine ions

D sodium boron hydride

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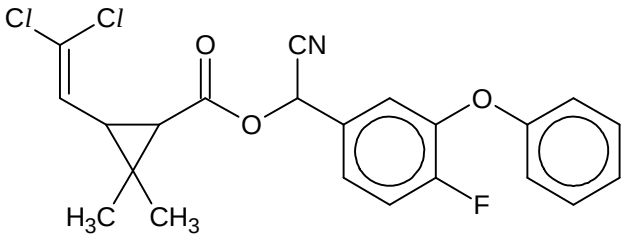
[Turn over

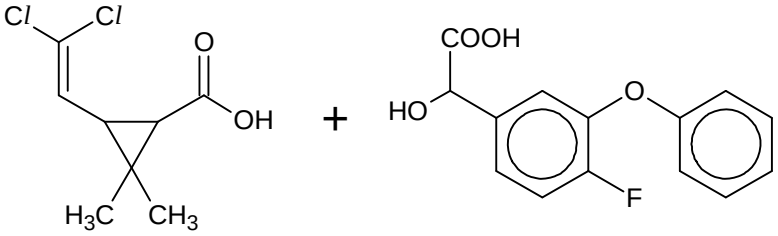
25 *Cyfluthrin* is a synthetic pyrethroid insecticide that has both contact and stomach poison action. It is a non-systemic chemical used to control ants, cockroaches, mosquitoes and many others.



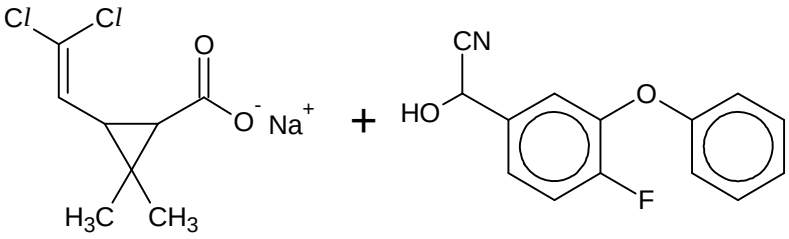
Cyfluthrin

What are the likely organic products from the reaction of *cyfluthrin* with an excess of boiling aqueous NaOH?

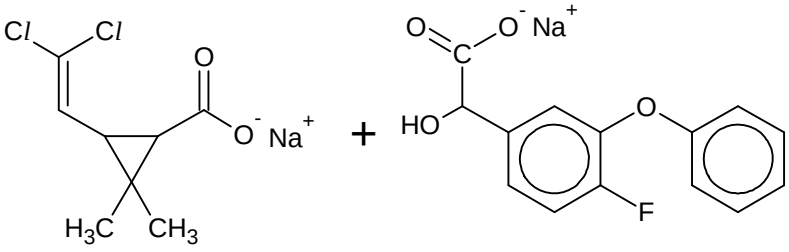
A



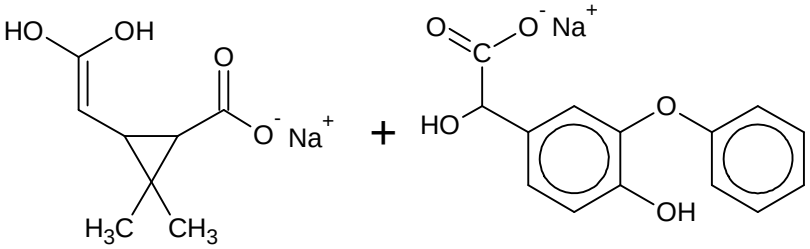
B



C



D



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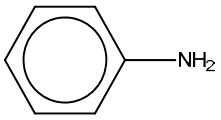
[Turn over

26 The pK_b values for some weak bases are given in the table below.

Base	**formula**	***pK*$_b$**
methylamine	CH_3NH_2	2.9
sodium carbonate	Na_2CO_3	3.7
phenylamine		9.3

An excess of sodium carbonate was added to an aqueous mixture consisting of salts of phenylamine and methylamine present in equal amounts.

Which of the following statements about the resultant mixture is true?

A The resultant mixture contains both methylamine and phenylamine.

B The resultant mixture contains both methylamine salt and phenylamine salt.

C The resultant mixture contains methylamine as well as phenylamine salt.

D The resultant mixture contains phenylamine as well as methylamine salt.

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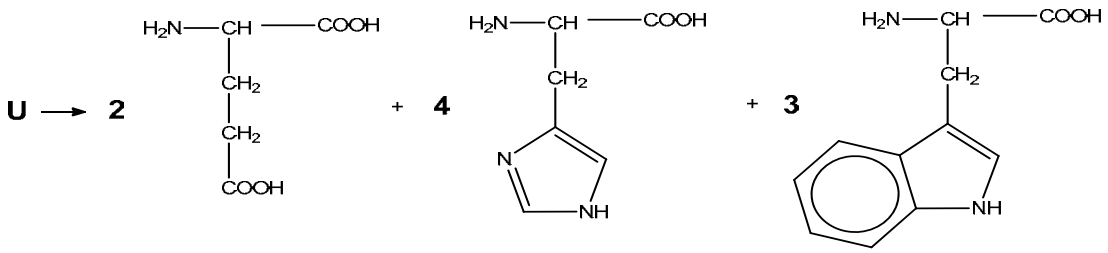
[Turn over

27 Peptidases are enzymes that begin protein catabolism by hydrolysis of the peptide bonds that bind amino acids together in the polypeptide chain of a protein.

Partial hydrolysis of a small peptide, **U**, by a peptidase, produces the following amino acids.



What is the M_r of the peptide **U**?

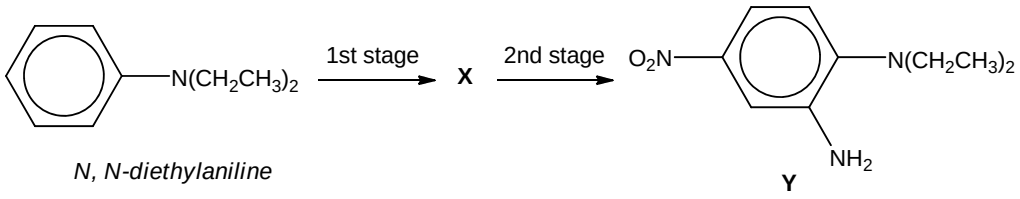
A 506

B 1364

C 1382

D 1526

28 *N, N-diethylaniline* is commonly used as an intermediate in the manufacture of dyes and pharmaceuticals. It is used in the following synthetic pathway to form compound **Y**.



The reactivity of *N, N-diethylaniline* is similar to that of phenylamine. What are the reagents required in this two stage synthesis?

	1st stage	2nd stage
A	dil HNO_3, rtp	$LiAlH_4$ in dry ether, rtp
B	dil HNO_3, heat	Sn, conc HCl, heat
C	conc HNO_3, rtp	$LiAlH_4$ in dry ether, rtp
D	conc HNO_3 & conc H_2SO_4, 30°C	Sn, conc HCl, heat

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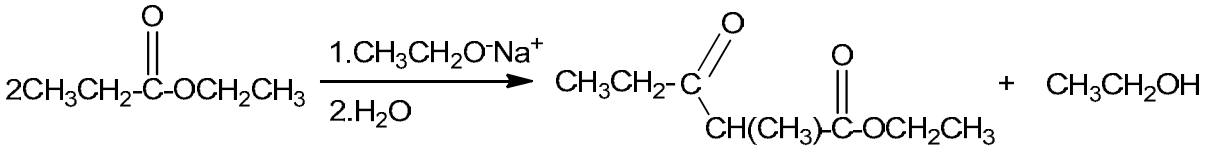
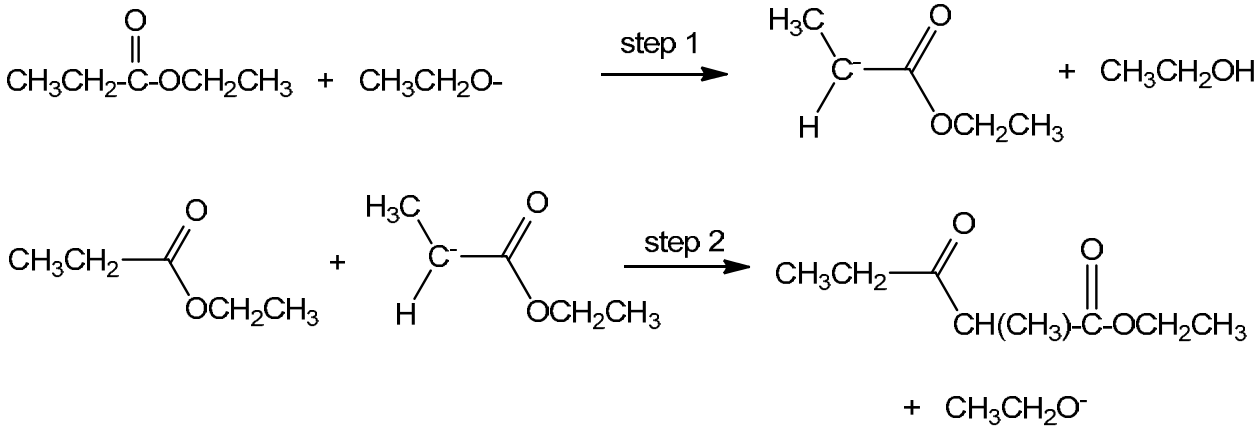
[Turn over

29 Claisen condensation is a carbon-carbon bond forming reaction that can occur between two esters, giving a β-keto ester. A typical example of the Claisen condensation is the reaction of two identical esters, $CH_3CH_2CO_2CH_2CH_3$, to form ethyl-2-methyl-3-oxopentanoate.



Two simplified steps in the Claisen condensation mechanism are given below.



Which of the following compounds could be possibly obtained from the Claisen condensation of $CH_3CH_2CO_2CH_3$ with $CH_3O^-Na^+$?

A $CH_3CH_2COCH_2CH_2COOCH_3$

B $CH_3CH_2COOCH_2COCH_2CH_3$

C $CH_3CH_2COCH(CH_3)COOCH_3$

D $CH_3CH_2COOCH(CH_3)COCH_3$

30 Chlorofluorocarbons (CFCs) have been widely used in aerosol sprays, refrigerators and in making foamed plastics, but are now known to destroy ozone in the upper atmosphere.

What will **not** destroy ozone, and therefore can be used safely as a replacement for CFCs?

A $CHBr_3$

B CCl_3CBr_3

C $CHClFCClF_2$

D $CH_3CHFCH_2CH_2F$

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[Turn over

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 which 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 In an experiment, two moles of methylamine, CH_3NH_2 was added to one mole of gaseous beryllium fluoride, BeF_2 in a container of fixed volume at a constant temperature.

Which of the following statements are correct?

1 The bond angle around each central atom in the product is 109^o.

2 The sign for the standard enthalpy change of reaction is negative.

3 There is an increase in the final pressure of the system after the methylamine had reacted completely with the beryllium fluoride.

32 Which statements concerning the lattice structure of graphite and diamond are correct?

1 The C−C−C bond angle between nearest neighbours is smaller in diamond than in graphite.

2 All covalent bonds in diamond are of the same strength but those in graphite are not.

3 The shortest carbon-carbon bond occurs in diamond.

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[Turn over

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 Theoretical values have been obtained for the two compounds Sr*Cl*(s) and SrCl_3(s) as shown below.

Compound	Sr*Cl* (s)	SrCl_3 (s)
Lattice energy/ kJ mol^{-1}	- 632	- 4560
Sum of enthalpies of hydration of separate ions / kJ mol^{-1}	-1080	- 2320

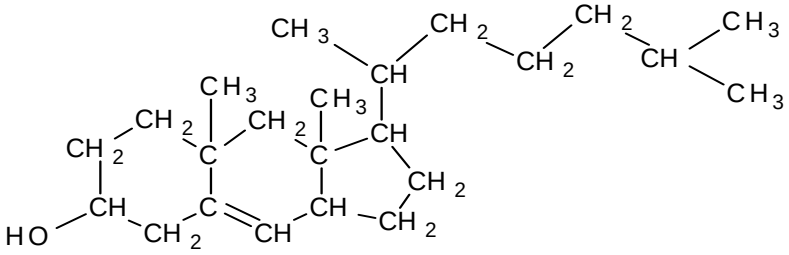
Which statements are correct?

1 Sr*Cl* is more soluble than SrCl_3.

2 The strength of interaction with water molecules is greater in Sr*Cl* compared to SrCl_3.

3 The electrostatic attraction between oppositely charged ions is stronger in Sr*Cl* compared to SrCl_3.

34 The compound *cholesterol* has the following structure.



Which statements are correct?

1 *Cholesterol* reacts with a mixture of ethanoic acid and concentrated sulfuric acid.

2 *Cholesterol* can be oxidised by hot acidified potassium dichromate.

3 *Cholesterol* reacts with bromine to form a compound which has two chiral centres.

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[Turn over

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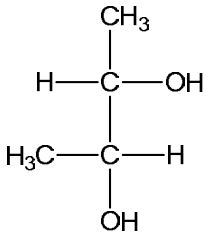
1, **2** and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

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

35 The effect of plane polarised light on *butan-2,3-diol* was studied.



butan-2,3-diol

It was identified that there are three different types of molecules, **P**, **Q** and **R** and the following observations were made with respect to each molecule:

Molecule **P** rotated plane polarised light in the clockwise direction

Molecule **Q** rotated plane polarised light in the anti-clockwise direction

Molecule **R** had no effect on plane polarised light

Which of the following statement(s) can be deduced from the above observations?

1 Molecule **R** does not have any chiral carbon.

2 Molecules **P** and **Q** are a pair of enantiomers.

3 Molecule **R** has a plane of symmetry within the molecule but not for molecules **P** and **Q**.

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[Turn over

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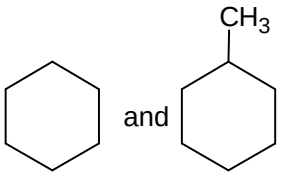
1, **2** and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

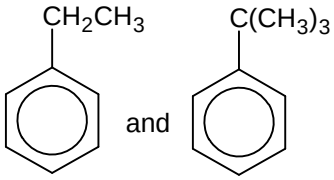
No other combination of statements is used as a correct response.

36 Which pair of organic compounds **cannot** be distinguished by a chemical test?

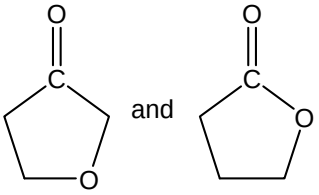
1



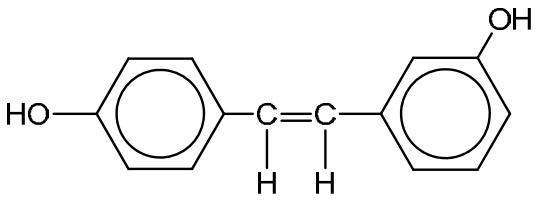
2



3



37 *Reversatrol* is an insect repellent which is emitted by damaged plants. A derivative of this repellent, compound **P** is shown below



Compound **P**

Which reactions will **P** undergo?

1 On reacting with HBr gas, one mole of HBr is used up per mole of **P**.

2 Addition of liquid bromine causes four bromine atoms to be incorporated per molecule of **P**.

3 On reacting with cold $KMnO_4$ in aqueous NaOH, four sodium ions are incorporated per molecule of **P**.

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[Turn over

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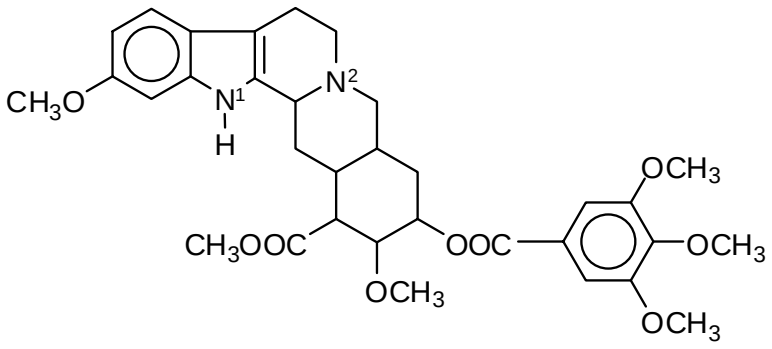
1, **2** and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

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

38 *Reserpine* is an antipsychotic and antihypertensive drug used for the control of high blood pressure and relief of psychotic behaviours.

[The ether $-OCH_3$ group is inert]



Which statements are correct?

1 The *reserpine* molecule has 6 chiral centres.

2 When treated with an excess of hot NaOH, *reserpine* will produce 3 organic compounds.

3 The N atom labeled $N^{\mathbf{1}}$ has a lower pK_b than the N atom labeled $N^{\mathbf{2}}$.

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[Turn over

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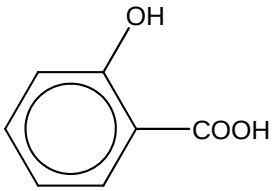
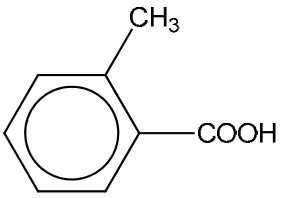
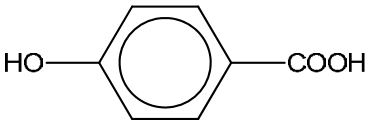
No other combination of statements is used as a correct response.

39 The following table compares the pK_{a1} values of various benzoic acids.

acid	formula	pK_{a1}
salicylic acid		2.97
o-toluic acid		3.91
4-hydroxybenzoic acid		4.58

Which of the following explanations best account for the differences in the pK_{a1} values?

1 In *o*-toluic acid, the presence of the electron-donating group, -CH_3, destabilises the anion.

2 In salicylic acid, there is stabilisation of the monoanion via intramolecular hydrogen bonding.

3 In 4-hydroxybenzoic acid, the lone pair of electrons on oxygen atom of phenol interacts with the electron cloud of the benzene ring, hence stabilising the anion.

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[Turn over

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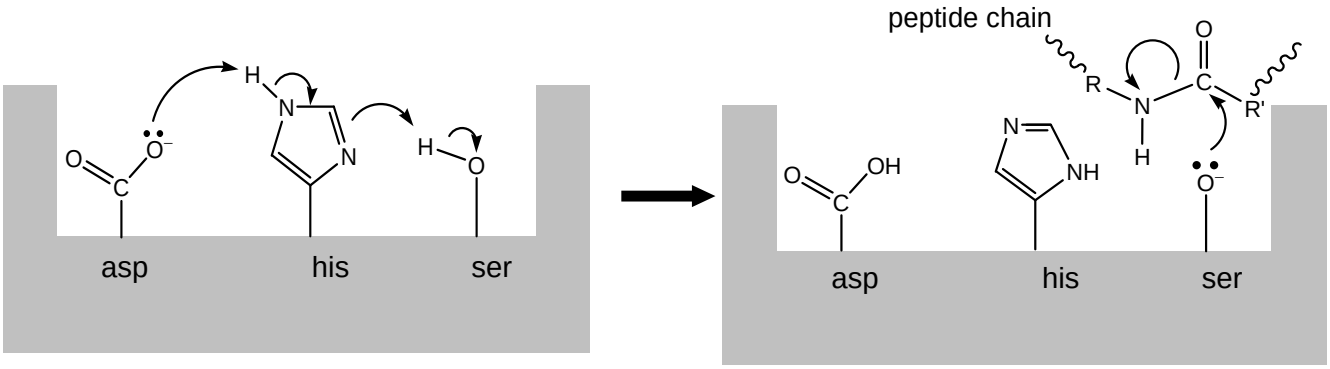
No other combination of statements is used as a correct response.

40 *Papain* is a relatively heat resistant enzyme, with an optimal temperature range of 60-70 °C. The three main amino acids involved in the catalytic activity of *papain* at the active site are His48, Asp102 and Ser185.

The first stage in the mechanism of the action of *papain* is illustrated in the figure below.



With reference to the figure above, which of the following best explains why the action of this enzyme would be inhibited if the pH was too low.

1 The carboxylate ion of aspartame will be protonated.

2 The alcohol group in serine can no longer act as an effective nucleophile to bring about hydrolysis.

3 The active site of the enzyme remains unaltered.

End of Paper 1

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[Turn over

Answers

1	**D**	**11**	**D**	**21**	**D**	**31**	**B**
2	**C**	**12**	**A**	**22**	**D**	**32**	**D**
3	**D**	**13**	**C**	**23**	**C**	**33**	**D**
4	**D**	**14**	**B**	**24**	**D**	**34**	**B**
5	**C**	**15**	**C**	**25**	**C**	**35**	**C**
6	**A**	**16**	**A**	**26**	**D**	**36**	**D**
7	**C**	**17**	**A**	**27**	**C**	**37**	**B**
8	**B**	**18**	**D**	**28**	**B**	**38**	**B**
9	**B**	**19**	**A**	**29**	**C**	**39**	**B**
10	**C**	**20**	**D**	**30**	**D**	**40**	**B**

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[Turn over