SERANGOON JUNIOR COLLEGE
General Certificate of Education Advanced Level
Higher 2

Candidate Name

Class

CHEMISTRY 9647/01

JC2 Preliminary Examination 30 Aug 2013
Paper 1 Multiple Choice 1 hour
Additional Materials: Data Booklet
Optical Mark Sheet (OMS)

READ THESE INSTRUCTIONS FIRST

On the separate multiple choice OMS given, write your name, subject title and class in the spaces provided.
Shade correctly your FIN/NRIC number.

There are **40** 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 using a **soft pencil** on the separate OMS.
Each correct answer will score one mark.
A mark will not be deducted for a wrong answer.

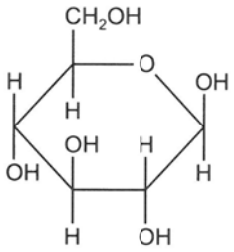
You are advised to fill in the OMS as you go along; no additional time will be given for the transfer of answers once the examination has ended.

Any rough working should be done in this question paper.

This document consists of **18** printed pages and **2** blank pages.

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

1 The diagram below shows the structural formula of glucose.



When glucose reacts with hot acidified potassium dichromate(VI), how many moles of water are formed? Assume the cyclic ring remains intact after the reaction.

A 4

B 5

C 6

D 7

2 Cluster decay is one rare instance of scientific phenomena predicted before experimental discovery, where a parent atomic nucleus emits a cluster of neutrons and protons that are heavier than an α-particle. One of the first predictions was the nuclear decay of radium-223.

$$^{223}_{88}\mathrm{Ra} \rightarrow {}^{14}_{6}\mathrm{C} + \mathbf{A}$$

Which row in the table correctly describes the nuclear make-up of element **A**?

	Number of protons	Number of neutrons
A	74	119
B	82	127
C	74	209
D	82	217

3 A given mass of ideal gas occupies a volume *V* and exerts a pressure *p* at 30 ^{o}C.
At which temperature will the same mass of the ideal gas occupy a volume $\frac{V}{3}$ and exert a pressure 2*p*?

A 20 ^{o}C

B 20 K

C 202 ^{o}C

D 202 K

4 The boiling point of water (100 ^{o}C) is greater than that of ammonia (–33 ^{o}C).

Which statement is a correct explanation of this?

A Ammonia has intramolecular hydrogen bonds, which water does not have.

B The M_r of water is greater than that in ammonia, so van der Waals' forces are stronger in water.

C There are, on average, more hydrogen bonds between water molecules than there are between ammonia molecules.

D The O–H bond requires 460 kJ mol^{-1} to overcome, while the N–H bond only requires 390 kJ mol^{-1} to overcome.

5 The standard enthalpy change of formation of hydrazine, $N_2H_4(g)$, is x kJ mol^{-1}.
The bond energy of the N≡N bond is y kJ mol^{-1}.
The bond energy of the H–H bond is z kJ mol^{-1}.

What is the standard enthalpy change of atomisation of hydrazine?

A ($x + y + 2z$) kJ mol^{-1}

B ($y + 2z – x$) kJ mol^{-1}

C ($x + 2y + 4z$) kJ mol^{-1}

D ($2y + 4z – x$) kJ mol^{-1}

6 The $\Delta G_{solution}^{\theta}$ and $\Delta S_{solution}^{\theta}$ for silver chloride are +55.6 kJ mol^{-1} and +33.2 J mol^{-1} K^{-1} respectively.

What is the enthalpy change when 287 g of silver chloride is precipitated under the same conditions?

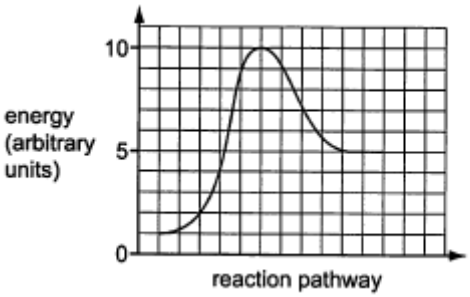
A +65.5 kJ

B –65.5 kJ

C +131 kJ

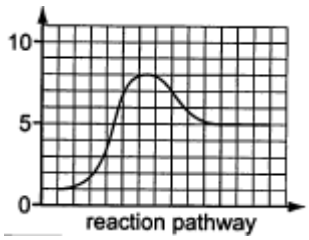
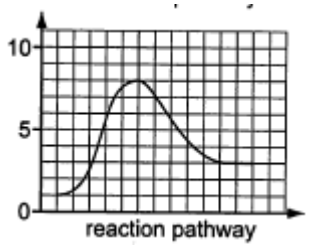
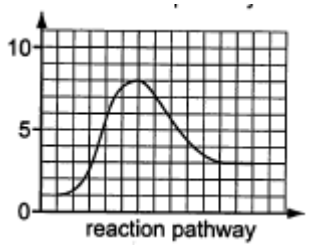
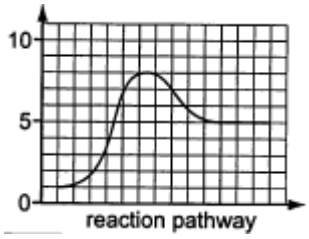
D –131 kJ

7 The diagram shows the reaction pathway diagram for an uncatalysed reversible reaction.



The reaction was then catalysed.

What are the changes in the rate constant, equilibrium constant and the reaction pathway diagram?

	Rate constant, k	Equilibrium constant, K_c	Energy profile
A	Unchanged	Increase	
B	Increase	Unchanged	
C	Increase	Increase	
D	Increase	Unchanged	

8 Steam dissociates at an initial pressure of 1 atm at *T* K to form hydrogen gas and oxygen gas.

$$2H_2O(g) \rightleftharpoons 2H_2(g) + O_2(g)$$

If the total pressure at equilibrium is 1.3 atm, what is the numerical value of the equilibrium constant, K_p, of the reaction at *T* K?

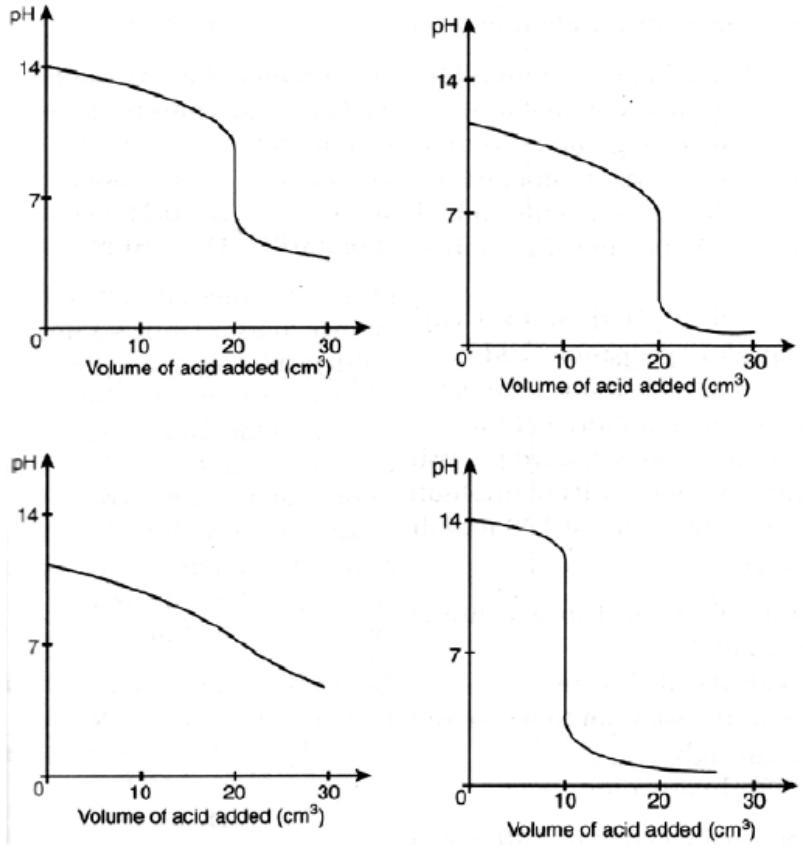
A 0.028

B 0.135

C 0.450

D 0.675

9 The following graphs show the change in pH when four different pairs of acid and base were titrated against each other.



In each titration, a 1.0 mol dm^{-3} solution of an acid is gradually added to 20 cm^3 of a 1.0 mol dm^{-3} solution of a base.

Which pair of solutions **could not** have given any of the graphs above?

A HNO_3 and NH_3

B HC*l* and $Ca(OH)_2$

C H_2SO_4 and NaOH

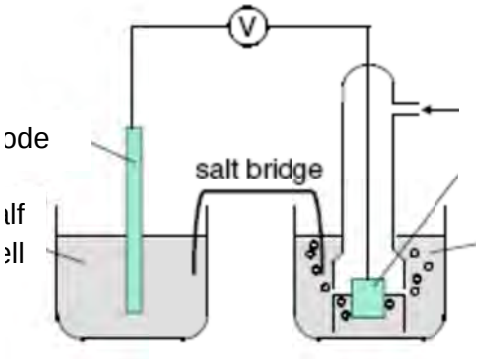
D CH_3COOH and NH_3

10 A solution contains 1 x 10^{-3} mol dm^{-3} of bromide, fluoride, iodide and sulfate ions. Which lead (II) compound will be precipitated first when 0.01 mol dm^{-3} of lead (II) nitrate is added dropwise to the solution at 25 ^{o}C?

	Compound	Solubility product at 25 ^{o}C
A	Lead (II) bromide	4.0 x 10^{-5}
B	Lead (II) sulfate	1.6 x 10^{-8}
C	Lead (II) fluoride	2.7 x 10^{-8}
D	Lead (II) iodide	7.1 x 10^{-9}

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

The diagram represents an experiment to determine the value of the E^{θ} (Sn^{2+}(aq)/Sn(s)), the standard electrode potential of tin



)

The e.m.f of the cell was found to be 0.18 V rather than the expected 0.14 V.
Two students, ***B*** and ***C***, suggested possible explanation.

B: [H^{+} (aq)] was greater than 1.00 mol dm^{-3}.

C: [Sn^{2+}(aq)] was greater than 1.00 mol dm^{-3}.

Which of their suggestions could be correct?

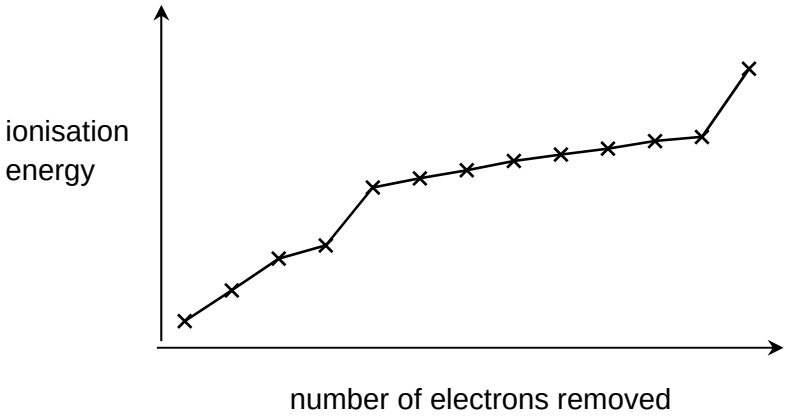
A Both ***B*** and ***C***

B ***B*** only

C ***C*** only

D Neither ***B*** nor ***C***

12 The graph below shows the first thirteen ionisation energies for element **D**.



What can be deduced from the graph about element **D**?

A It is a transition element.

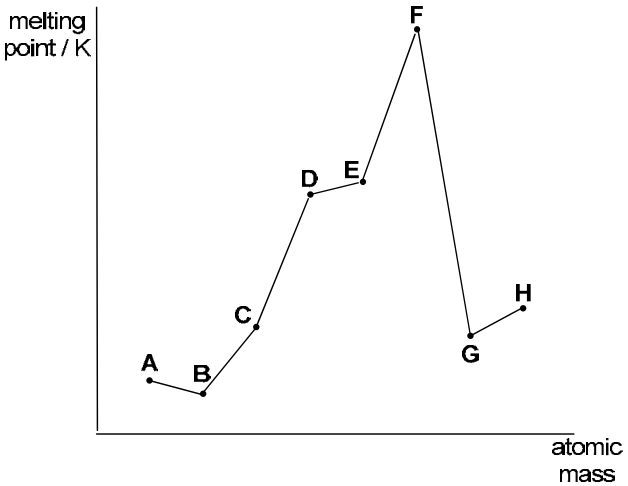
B It is in Group IV of the Periodic Table.

C It has one electron in its outermost shell.

D It is in the third period (Na to Ar) of the Periodic Table.

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

The graph below shows the variation in the melting points for eight consecutive elements in the Periodic Table, all with atomic number below 20.



What statement is correct?

A Element **D** burns with a brilliant yellow flame.

B Element **F** conducts electricity at room temperature.

C Element **H** does not react with air at room temperature.

D Element **C** is a gas which is chemically inert at room temperature.

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

Zinc and magnesium are metals that are widely used in alloys such as Mazak which is used to make die-cast toys. Each metal forms many compounds containing a M^{2+} ion.

Which statement about the electron arrangements in the atoms and ions of zinc and magnesium is correct?

A A zinc atom has fewer electrons than a magnesium atom.

B A Zn^{2+} ion has one more occupied electron shell than a Mg atom.

C A Zn atom has two more occupied electron shells than a Mg^{2+} ion.

D A Zn^{2+} ion has an outer electronic configuration of $4s^2$, while a Mg^{2+} ion has an outer electronic configuration of $3s^2$.

15 How would the magnitude of the following vary down Group II?

(i) the lattice energy of the sulfate, ΔH^{θ}_{latt},
(ii) the standard enthalpy change of hydration of M^{2+} (g), ΔH^{θ}_{hyd},
(iii) the standard enthalpy change of solution of the sulfates, ΔH^{θ}_{soln}.

	ΔH^{θ}_{latt}	ΔH^{θ}_{hyd}	ΔH^{θ}_{soln}
A	decreases	decreases	increases
B	decreases	increases	increases
C	increases	decreases	decreases
D	increases	increases	decreases

16 Which statement is most likely to be true for astatine, the element below iodine in Group VII of the Periodic Table?

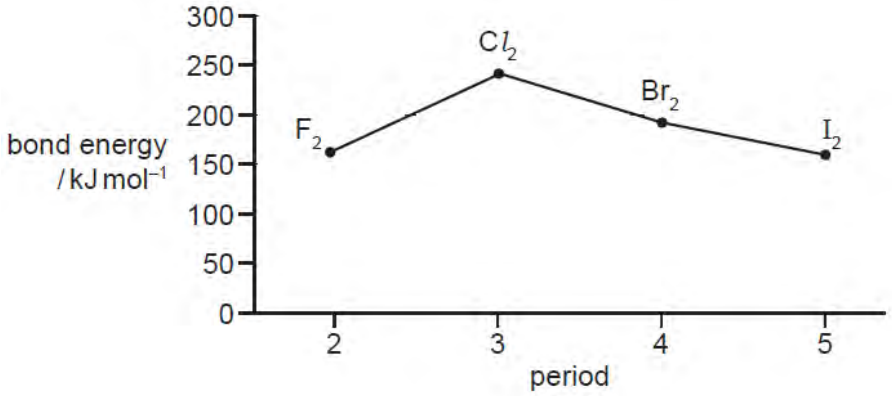
A Astatine reacts with aqueous sodium bromide to given aqueous sodium astatide and bromine.

B Astatine reacts with aqueous iron(II) ions to give iron(III) ions.

C Hydrogen iodide is more acidic than hydrogen astatide.

D Silver astatide has a lower K_{sp} value than silver iodide.

17 The diagram shows bond energies in halogen molecules.



Why does the value for fluorine **not** follow the trend shown by chlorine, bromine and iodine?

A Fluorine is more electronegative than the other halogens.

B Lone electron pairs in fluorine repel more strongly than those in the other halogens.

C The bonds in fluorine are more polar than those in the other halogens.

D The bonds in fluorine have some π-character.

18 An element **J** has the electronic configuration [Ar] $3d^3\ 4s^2$ and forms a series of oxohalides.

Which oxohalide of **J** is **not** likely to be formed?

A $\mathbf{J}O_3$

B $\mathbf{J}O_2^+$

C $\mathbf{J}O_3^-$

D $\mathbf{J}Cl_3$

19 Platinum (IV) chloride combines with ammonia to form compounds in which the coordination number of platinum is 6. A formula unit of one of the compounds contains a cation and only one chloride ion.

What is the formula of this compound?

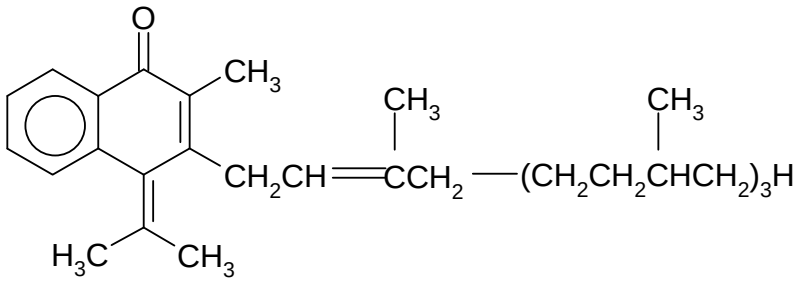
A $Pt(NH_3)_6Cl_4$

B $Pt(NH_3)_5Cl_4$

C $Pt(NH_3)_4Cl_4$

D $Pt(NH_3)_3Cl_4$

20 Compound **P** is a yellow viscous oil found in plants. It has the following structure.



What is the total number of stereoisomers for compound **P**?

A 4

B 8

C 16

D 32

21 Consider the following reactions.

Reaction	Reactants	Conditions
I	CH_4, Br_2	UV light
II	$CH_2{=}CH_2$, Br_2	CCl_4

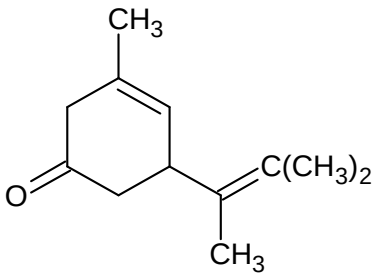
Which of the following is correct about the carbon-containing intermediates formed in the two reactions?

	Carbon-containing intermediate in Reaction I	Carbon-containing intermediate in Reaction II
A	pyramidal	electron deficient
B	pyramidal	planar
C	planar	electron rich
D	planar	pyramidal

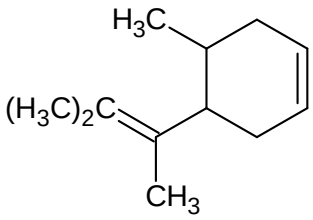
22 An organic compound, on heating with an excess of hot concentrated acidic $KMnO_4(aq)$, produces $CH_3COCH_2COCH_2CH_2COCH_2COOH$ and CH_3COCH_3.

What could the organic compound be?

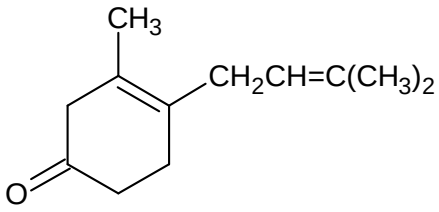
A



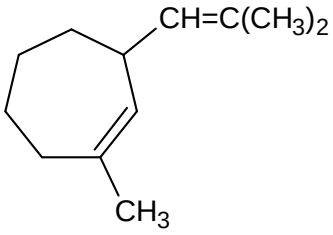
B



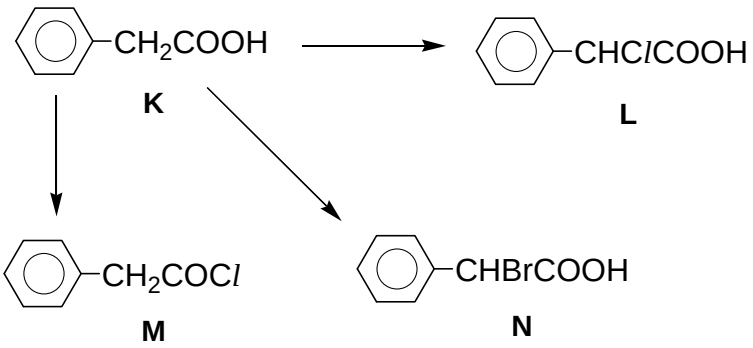
C



D



23 Three halogeno compounds can be synthesised from an organic compound **K** by the following routes:

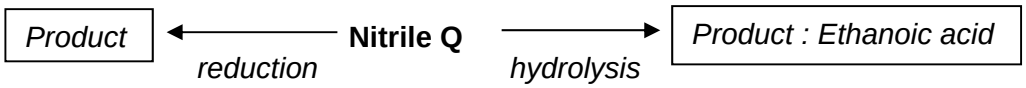


When compounds **K**, **L**, **M** and **N** (not necessarily in that order) are added to separate portions of water, solutions are formed with pH values of 0.5, 2.5, 3.0 and 3.5.

Which pH value is associated with **K**, **L**, **M** and **N**?

	pH = 0.5	pH = 2.5	pH = 3.0	pH = 3.5
A	**L**	**N**	**K**	**M**
B	**K**	**N**	**L**	**M**
C	**M**	**K**	**N**	**L**
D	**M**	**L**	**N**	**K**

24 Nitrile **Q** undergoes the two reactions as shown below.



What would be produced when the two products from the two reactions are mixed?

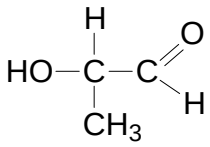
A $CH_3CONHCH_2CH_3$

B $CH_3CH_2CONHCH_2CH_3$

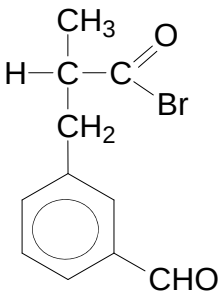
C $[CH_3CH_2NH_3^+][CH_3COO^-]$

D $[CH_3CH_2CH_2NH_3^+][CH_3CH_2COO^-]$

25 Which reagent cannot be used to distinguish between compounds **R** and **S** under suitable conditions?



R



S

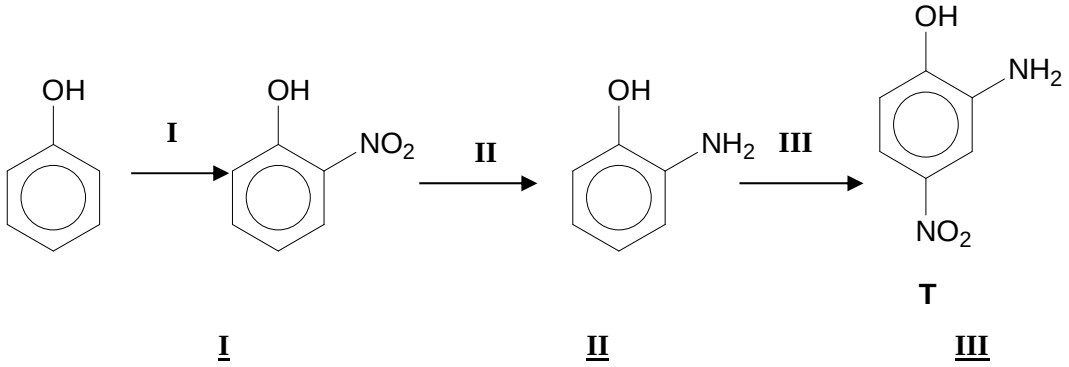
A alkaline iodine solution

B alkaline copper(II) solution

C ethanolic silver nitrate solution

D silver diammine complex

26 Compound **T** can be made from phenol. Which are the correct reagents and conditions for steps **I**, **II** and **III** of this synthesis?



	I	**II**	**III**
A	concentrated HNO_3, r.t.p.	$LiAlH_4$ in dry ether, r.t.p.	Aqueous NH_3, heat
B	concentrated HNO_3, r.t.p.	Sn, excess concentrated HC*l*, reflux followed by NaOH(aq)	dilute HNO_3, r.t.p.
C	dilute HNO_3, r.t.p.	$LiAlH_4$ in dry ether, r.t.p.	Ethanolic NH_3, heat in a sealed tube
D	dilute HNO_3, r.t.p.	Sn, excess concentrated HC*l*, reflux followed by NaOH(aq)	dilute HNO_3, r.t.p.

27 Which sequence shows the correct order of increasing pK_b in an aqueous solution of equal concentration?

A $C_2H_5CONH_2 < C_2H_5NH_2 < C_2H_5NH_3^+Cl^- < C_2H_5COCl$

B $C_2H_5NH_2 < C_2H_5COOCH_3 < C_2H_5COOH < C_2H_5COCl$

C $C_2H_5NH_2 < C_2H_5CONH_2 < CH_3CH(Cl)COOH < C_2H_5COOH$

D $C_2H_5NH_3^+Cl^- < C_2H_5COOCH_3 < C_2H_5COOH < CH_3CH(Cl)COOH$

28 Phenylethanoate undergoes acid hydrolysis in the presence of water labelled with the ^{18}O isotope.

Which product is formed?

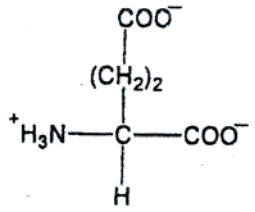
A $C_6H_5{}^{18}OH$

B $C_2H_5{}^{18}OH$

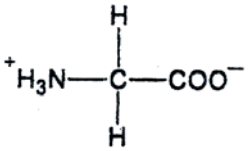
C $C_6H_5CO^{18}OH$

D $CH_3CO^{18}OH$

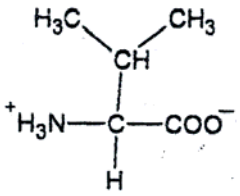
29 The following three amino acids exist as the following structures at neutral pH.



glutamic acid (Glu)

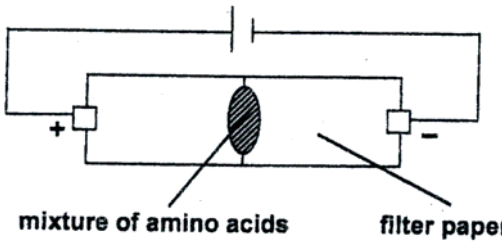


glycine (Gly)



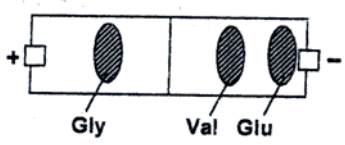
valine (Val)

A mixture containing the three amino acids was placed in a solution of pH 2 and subjected to electrophoresis as follows.

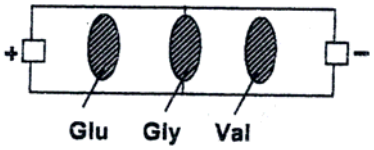


Which filter paper shows a possible result of the separation of the amino acid mixture at pH 2?

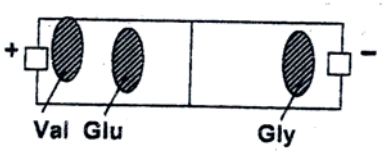
A



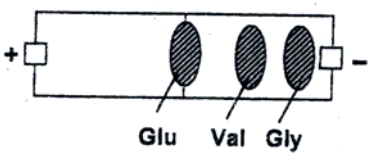
B



C



D



30 A hexapeptide, **U**, is hydrolysed to the following dipeptides:

Ileu–Val
Ala–Pro
Lys–Leu

Carboxypeptidase, an enzyme which hydrolyses the peptide bond of an amino acid residue at the C–terminus, acts on **U** to liberate valine. 2,4–dinitrofluorobenzene reacts with an amino acid residue at the N–terminus of **U** to form 2,4–dinitrophenylalanine.

Which is the amino acid sequence of polypeptide **U**?

A Ala–Pro–Lys–Leu–Ileu–Val

B Val–Ileu–Lys–Leu–Pro–Ala

C Ileu–Val–Ala–Pro–Lys–Leu

D Lys–Leu–Ala–Pro–Ileu–Val

For **questions 31 – 40**, one or more of the numbered statements **1** to **3** may be correct. Decide whether each of the statements is or is not 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 to be used as correct response.

31 Oxygen dissolved in the sea is critical for the survival of ocean life. It was found in a study that the solubility of oxygen is higher in water of lower salinity than in water of higher salinity. Oxygen is also more soluble in the colder, deeper parts of the ocean.

Which are possible explanations for the above observations?

1 The dissolving of oxygen in water is an exothermic process.

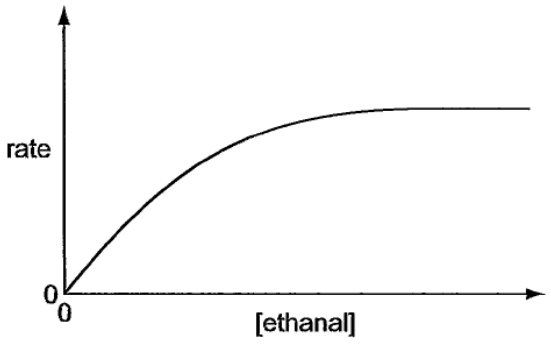
2 Oxygen is soluble in water due to intermolecular hydrogen bonding.

3 Oxygen is less soluble in water of higher salinity due to interference from ion-dipole interactions.

32 Alcohol dehydrogenases (ADH) are a group of dehydrogenase enzymes that occur in many organism and facilitate the interconverison between alcohols and aldehydes or ketone. In humans, they serve to break down alcohol which is toxic. It is also used in fermentation in the production of ethanol.

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

The graph shows how the rate of the enzyme-catalysed reaction varies with the concentration of ethanal.



Which statement best explains the reason for the flattening of the curve?

1 At high ethanal concentrations, all the active sites in the enzyme molecules are occupied by ethanal molecules.

2 As the ethanol product builds up, the reaction slows down.

3 All ethanal has been used up and the reaction is completed.

33 In which processes will ΔS be positive?

1 Evaporation of a solvent from a solution.

2 Adding a polar solute to a non-polar solvent.

3 Spreading out a solution on a clean surface.

34 In a car engine, non-metallic element **V** forms a pollutant oxide **W**.
Further oxidation of **W** to **X** occurs spontaneously in the atmosphere. In this further oxidation, 2 mol of **W** reacts with 1 mol of gaseous oxygen. **X** can dimerise at specific conditions.

Which statements about **V**, **W** and **X** are **correct**?

1 **V** forms a basic hydride.

2 **W** is a diatomic molecule.

3 **X** is a polar molecule.

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

The unbalanced equation below involves manganese species in acid medium.

$$MnO_4^{2-} \longrightarrow Mn^{2+} + MnO_4^-$$

Which statements are true?

1 This is a disproportionation reaction.

2 Unequal amounts of Mn^{2+} and MnO_4^- ions are formed.

3 The 3d electrons in Mn^{2+} ions are unpaired.

36 Which statements are true?

1 Pentan-1-ol is less soluble in polar solvent than ethanol.

2 The melting point of aminoethanoic acid is higher than that of ethanamide due to the presence of stronger hydrogen bonding present.

3 The boiling point of 2,2,3,3-tetramethylbutane is higher than 2,3,3-trimethylpentane due to the longer parent carbon chain which allow more extensive intermolecular van der Waals' forces of attraction.

37 Bacteria have been suggested as a possible means of cleaning up spillages. Some bacteria contain enzymes that can insert one or more oxygen atoms into any carbon-hydrogen bond in an alkane. This converts a water-insoluble alkane into a water-soluble alcohol, for example,

$$CH_3CH_3 \rightleftharpoons CH_3CH_2OH$$

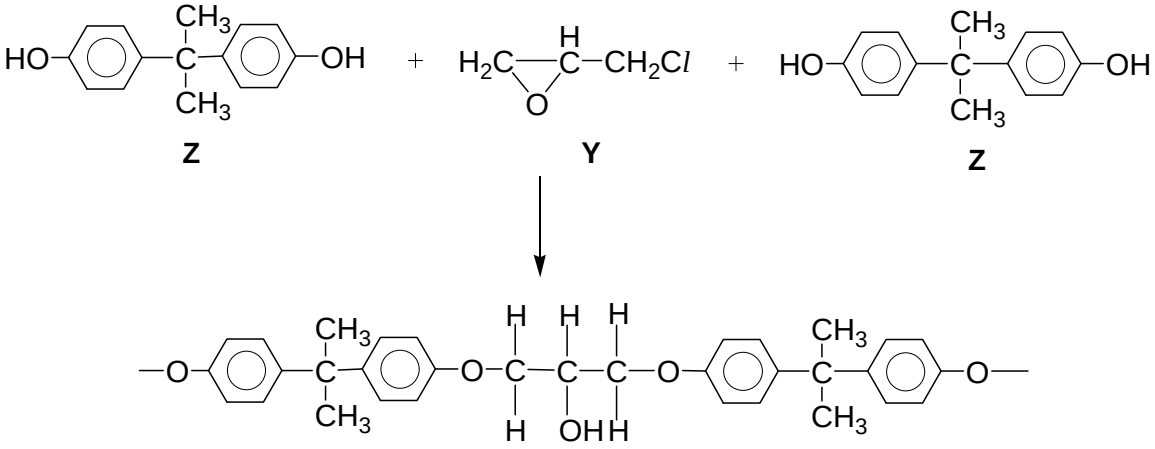
Which alcohols could be obtained by this process from $(CH_3)_2CHCH_2CH_3$?

1 $(CH_3)_2CHCH_2CH_2OH$

2 $CH_3CH(OH)CH(CH_3)_2$

3 $(CH_3)_2C(OH)CH(OH)CH_3$

38 Monomer **Y** reacts with diphenol **Z** to give a polymer as shown in the reaction scheme below.



Z + **Y** + **Z**

polymer

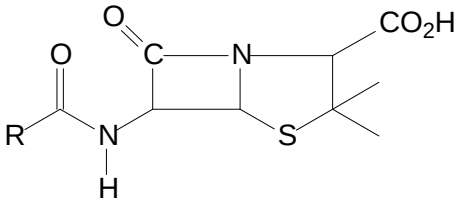
Which statements are correct?

1 In the reaction, nucleophilic substitution takes place.

2 One mole of HC*l* is removed for each unit of the polymer formed.

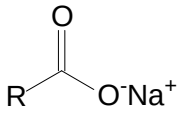
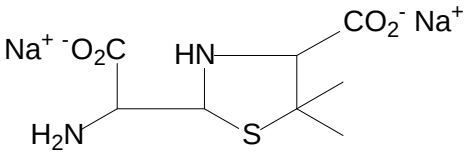
3 Both monomer **Z** and the polymer formed give a purple complex with neutral iron (III) chloride solution.

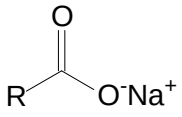
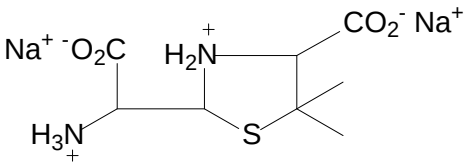
39 Penicillin is widely used to kill bacteria. The general structure of a penicillin molecule is given below.

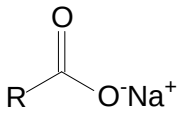
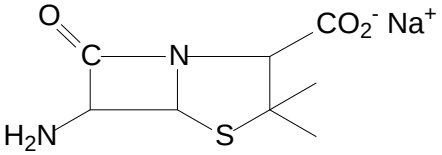


R = an aryl group

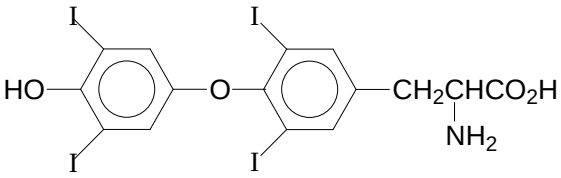
Which products are formed when penicillin is boiled with excess aqueous sodium hydroxide?

1  and 

2  and 

3  and 

40 *Thyroxine* is a hormone which controls the metabolic rate. It has the following structure:



Which properties of *thyroxine* are correct?

1 It can decolourise dilute chlorine at all temperatures.

2 It can form a tripeptide with cysteine and proline.

3 It can exist as zwitterions.

END