ST ANDREW'S JUNIOR COLLEGE

JC2 Preliminary Examinations

Chemistry Higher 2 **9647/01**

Paper 1 Multiple Choice **17th September 2015**

1 hour

Additional Materials: Multiple Choice Answer Sheet, Data Booklet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil. Do not use staples, paper clips, highlighters, glue or correction fluid.

There are **40** 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 separate Answer Sheet.

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 booklet.

This document consists of **25** printed pages **including** this page.

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 mass percentage of magnesium in a mixture of magnesium chloride (M_r = 95.3) and magnesium nitrate (M_r = 148.3) was found to be 21.25%. What mass of magnesium chloride is present in 323 g of the mixture?

A 151 g

B 165 g

C 172 g

D 181 g

2 Which conversion results in a loss of electrons for the underlined species?

A $\underline{N}O_3^-$ to $\underline{N}O_2$

B $\underline{N}O_2^-$ to $\underline{N}O_3^-$

C $\underline{S}_2O_8^{2-}$ to $\underline{S}O_4^{2-}$

D $\underline{S}_4O_6^{2-}$ to $\underline{S}_2O_3^{2-}$

3 Which of the following pairs shows Gas **Y** deviating more from ideal gas behaviour than Gas **X** at the same temperature and pressure?

	Gas **X**	Gas **Y**
A	HF	HC*l*
B	H_2O	H_2
C	I_2	Br_2
D	O_2	NO_2

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

Which of the following shows the correct increasing trend for the angle of deflection when placed in an electric field?

A $Cl^- < Ru^{3+} < Zn^{2+}$

B $Ru^{3+} < Cl^- < Zn^{2+}$

C $Cl^- < Zn^{2+} < Ru^{3+}$

D $Zn^{2+} < Ru^{3+} < Cl^-$

5 Which of the following **cannot** form dimers?

A CH_3COOH

B CH_3CHO

C $AlCl_3$

D NO_2

6 Which of the following species is planar and does not have dative bonding?

A PO_4^{3-}

B SO_4^{2-}

C CO_3^{2-}

D NO_3^-

7 The behavior of Group II sulfates and hydroxides show different trends down the group. Group II sulfates become less soluble down the group, while Group II hydroxides become more soluble down the group.

Which of the following statements helps to explain this trend?

A Down the group, the magnitude of the lattice energy of Group II hydroxides has a more significant decrease than the magnitude of the sum of hydration energies of the ions.

B Down the group, the magnitude of the lattice energy of Group II sulfates has a more significant decrease than the magnitude of the sum of hydration energies of the ions.

C The hydration energy of the sulfate anion is larger in magnitude than the hydroxide anion.

D The magnitude of the lattice energy of Group II ionic compounds increases down the group.

8 Phosphorus exists in several allotropes. White phosphorus has the structure P_4, while black phosphorus has a structure similar to graphite.

While the transformation of white phosphorus to black phosphorus is spontaneous, the rate is very slow, and usually involves the use of a metal salt catalyst to increase its rate.

Which of the following is true?

A Black phosphorus has a simple molecular structure.

B ΔH for the transformation of white phosphorus to black phosphorus is less than zero.

C ΔS for the transformation of white phosphorus to black phosphorus is greater than zero.

D The uncatalysed reaction of transforming white phosphorus to black phosphorus has a small activation energy.

9 What is the half-life of a first-order reaction where the concentration of the reactant drops to $\frac{1}{5}$ of its initial concentration after 51 minutes?

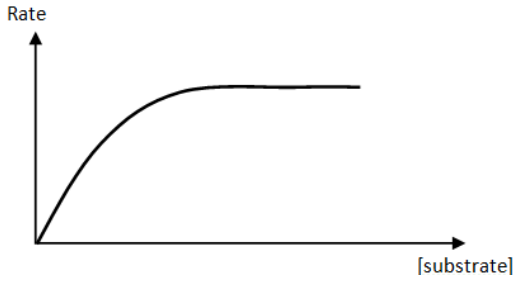
A 20 min

B 22 min

C 24 min

D 26 min

10 The graph below shows the change in rate for an enzyme-catalysed reaction.



Which of the following statements is **incorrect**?

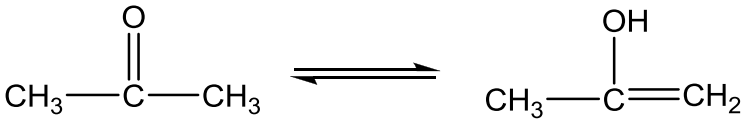
A At low [substrate], the rate is first order with respect to [substrate].

B At low [substrate], the reaction slows down due to increasing concentration of the products.

C At high [substrate], the rate is constant as all the enzyme active sites are used up.

D At high [substrate], increasing [enzyme] increases the rate.

11 A ketone such as propanone can undergo a rearrangement of its atoms to form an enol when dissolved in a non-polar solvent. Enols exist together with their ketone forms in equilibrium.



$\Delta H = +48 \text{ kJ mol}^{-1}$

Which of the following statements can be determined from the information above?

A Increasing the temperature results in the shift of the position of equilibrium to the left.

B The entropy change of the reaction is positive under aqueous conditions.

C Adding of warm alkaline iodine results in the shift of the position of equilibrium to the right.

D Adding sodium metal results in the shift of the position of equilibrium to the right.

12 Which of the following mixtures will result in a significant pH change when a small amount of acid is added?

A 20 cm^3 of 1 mol dm^{-3} H_2CO_3 and 20 cm^3 of 1 mol dm^{-3} $KHCO_3$

B 20 cm^3 of 1 mol dm^{-3} HCl and 20 cm^3 of 1 mol dm^{-3} $CH_3CH_2NH_2$

C 10 cm^3 of 1 mol dm^{-3} NaOH and 20 cm^3 of 1 mol dm^{-3} NH_4Cl

D 10 cm^3 of 1 mol dm^{-3} HCl and 20 cm^3 of 1 mol dm^{-3} $Mg(CH_3CH_2COO)_2$

13 The table below shows the numerical values of the solubility products for some salts.

Salt	$Pb(OH)_2$	$Zn(OH)_2$	$ZnCO_3$	Ag_2CO_3
$\mathbf{K_{sp}}$	1.4×10^{-20}	3.0×10^{-17}	1.4×10^{-11}	8.1×10^{-12}

Which statement is **correct**?

A $Pb(OH)_2$ is more soluble than $Zn(OH)_2$.

B $Zn(OH)_2$ is more soluble than $ZnCO_3$.

C Ag_2CO_3 is more soluble than $ZnCO_3$.

D $Pb(OH)_2$ is more soluble than Ag_2CO_3.

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

Pure copper wires when used in electrochemical cells are partially submerged in the electrolyte. Which aqueous electrolyte can be used such that the copper wires do not dissolve?

A KNO_3

B $K_2S_2O_8$

C $Na_2Cr_2O_7$

D $Na_2S_4O_6$

15 3.96 g of metal was deposited when 1.602 x 10^4 C of electricity was passed through a molten electrolyte.

Which of the following could be the electrolyte?

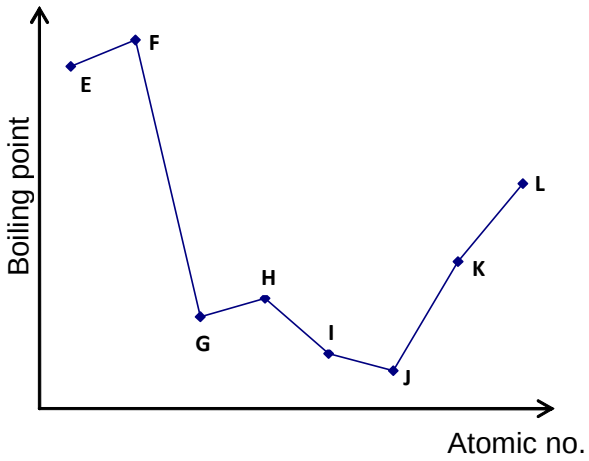
A TiC*l*

B $TiSO_4$

C Ti_2O_3

D TiO_2

16 The graph below shows the variation in the boiling points for eight consecutive elements in the Periodic Table, all with atomic number between 10 and 20.



Which of the following statements is true?

A Element **H** forms an acidic oxide.

B Element **K** does not conduct electricity.

C Element **E** and beryllium are in the same group.

D The element preceding **E** has a smaller atomic radius than **E**.

17 Radium is a radioactive element below barium in the Periodic Table.

Which statement concerning radium is **not** true?

A It is a good conductor of electricity.

B Radium nitrate has a higher thermal stability than barium nitrate.

C Radium dissolves in water at room temperature to form a strongly basic solution.

D Radium has an outermost electronic configuration of $6s^2$.

18 Chlorine and iodine are both elements in Group VII, but have some differences in their reactivity and properties of their compounds.

Which of the following would increase from chlorine to iodine?

A oxidation state of sulfur when the halogens reacts with sodium thiosulfate

B bond energy of molecules of the elements

C strength of the van der Waals' forces between molecules of the elements

D solubility product of the silver halide

19 Which of the following statements is true about the d-block elements in Period 4 and their compounds?

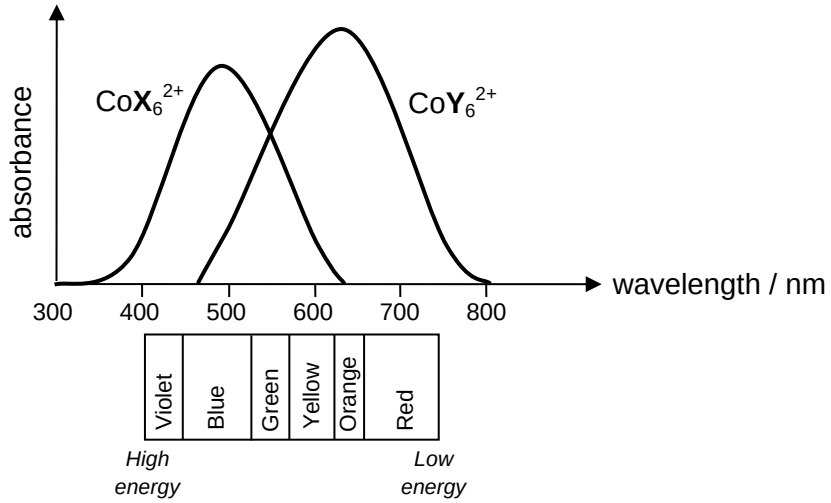
A Chromium has the most number of oxidation states.

B Cu^+ has 1 unpaired electron in its ground electronic configuration.

C Ni^{2+} is less likely to be reduced when dissolved in aqueous ammonia.

D Scandium can form coloured complexes and can exhibit variable oxidation states.

20 The diagram below shows the visible spectra of two cobalt(II) complexes, Co$\mathbf{X}_6^{2+}$ and Co$\mathbf{Y}_6^{2+}$. The various colours corresponding to the approximate wavelengths in the visible light region are shown below the x-axis. The shorter the wavelength of light, the higher its energy.



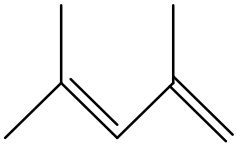
What is the colour of complex Co$\mathbf{Y}_6^{2+}$ and which ligand causes a larger d-orbital splitting?

	colour of Co$\mathbf{Y}_6^{2+}$	**ligand which causes a larger d-orbital splitting**
A	yellow orange	**X**
B	yellow orange	**Y**
C	violet	**X**
D	violet	**Y**

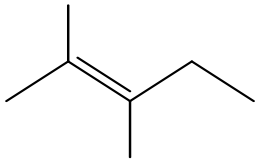
21 An alkene reacted with cold acidified $KMnO_4(aq)$ to form a product which has a single chiral carbon atom. However the product does not react with hot acidified $KMnO_4(aq)$.

Which is the following is a possible structure of the alkene?

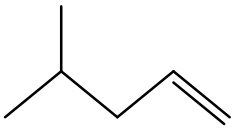
A



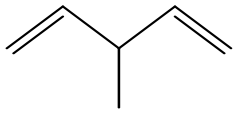
C



B



D



22 **W**, **X** and **Y** are three different organic compounds. Both **X** and **Y** can react with **W** to form an ester each, but **Y** reacts much less readily than **X**.

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

A propanol

B propanoic acid

C propanoyl chloride

D propanamide

23 Which of the following reagents is most suitable to distinguish between dilute methanoic acid and methanal?

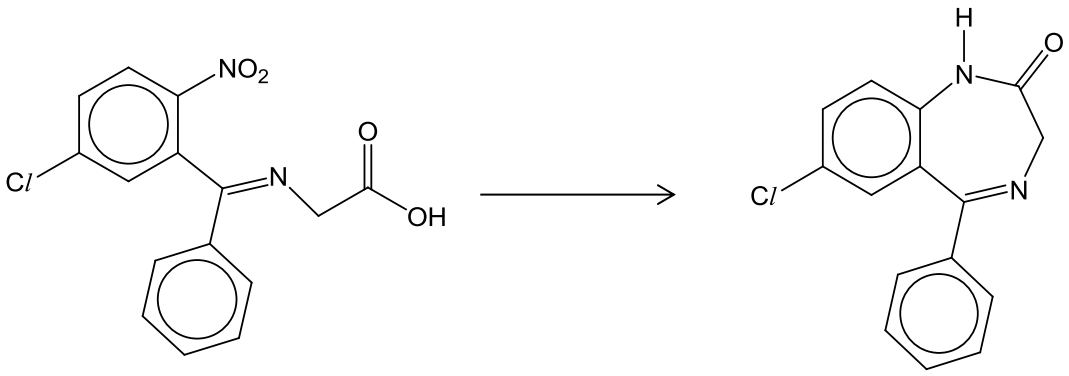
A HCN

B Hot acidified $KMnO_4$

C 2,4-DNPH

D NaOH

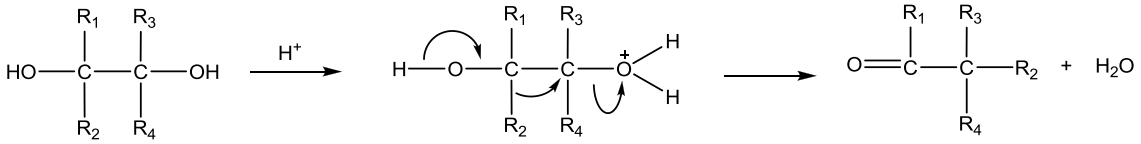
24 Demethylated diazepam can be used as an anti-depressant drug to treat anxiety. Which of the following correctly shows the sequence of reactions to convert compound **X** to demethylated diazepam?



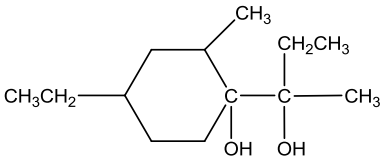
Compound X **demethylated diazepam**

	Step I	**Step II**
A	PCl_5	$LiAlH_4$ in dry ether
B	PCl_5	Sn, conc HCl, heat, followed by NaOH(aq)
C	$NaBH_4$	PCl_5
D	Sn, conc HCl, heat, followed by NaOH(aq)	PCl_5

25 The pinacol rearrangement involves the reaction of a diol in acidic conditions to form a carbonyl compound as shown below.

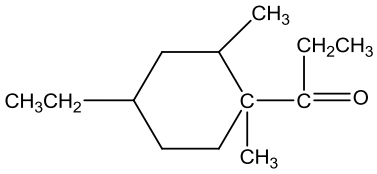


Which structural formulae is **not** a product of the pinacol rearrangement of compound **X**?

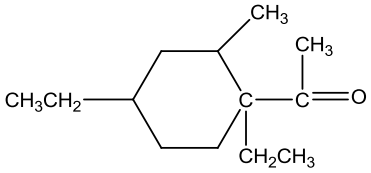


Compound **X**

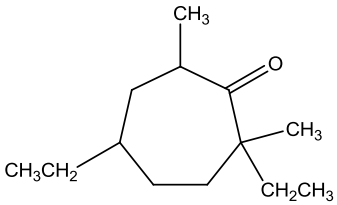
A



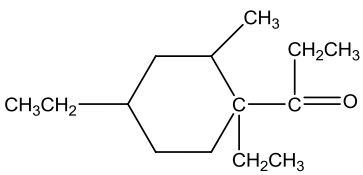
B



C

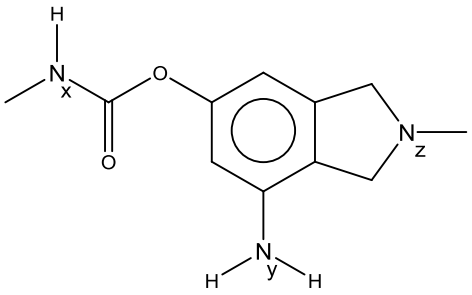


D



26 Physostigmine is an alkaloid which occurs naturally in the Calabar bean.

Compound **G** is a derivative of Physostigmine.



Compound **G**

The 3 nitrogen atoms are labelled as N_X to N_z.

What is the increasing order of basicity of the 3 nitrogen atoms?

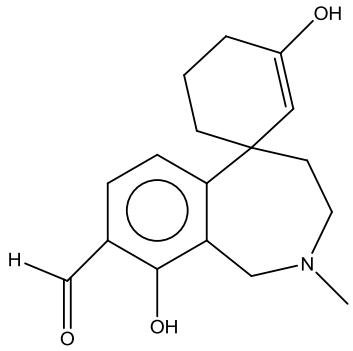
A $N_x < N_z < N_y$

B $N_x < N_y < N_z$

C $N_z < N_x < N_y$

D $N_y < N_x < N_z$

27 Galanthamine is a drug used to treat Alzheimer's disease. Compound **X** is its isomer**.**



Compound **X**

Which of the following statements about compound **X** is correct?

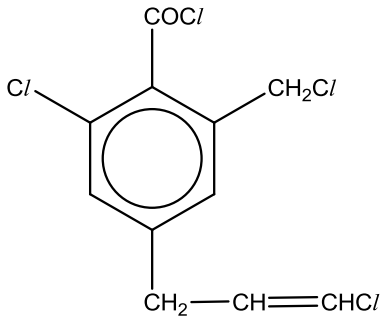
A It reacts with alkaline Cu^{2+} to give a brick red ppt.

B It reacts with 3 moles of ethanoyl chloride.

C It gives a violet colouration with acidic $FeCl_3$

D It reacts with 2 moles of aqueous bromine.

28 How many moles of silver chloride will be precipitated when excess aqueous silver nitrate is added to one mole of the compound below?



A 0

B 1

C 2

D 4

29 In the hydrogenation of $CH_2=CHCH_2CN$ using platinum catalyst, what is the volume of hydrogen gas (measured at s.t.p) that is required to react completely with 1 mole of the compound?

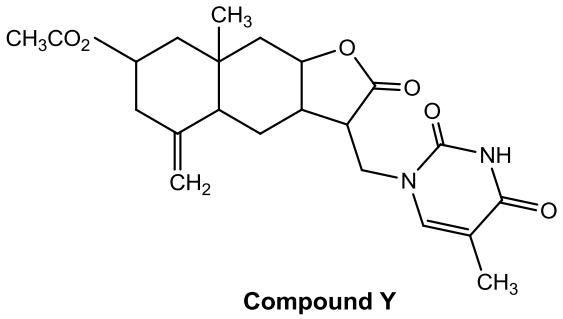
A 22.4 dm^3

B 24.0 dm^3

C 67.2 dm^3

D 72.0 dm^3

30 Compound **Y** was extracted from sunflowers and was known to possess anti-tumour effects.



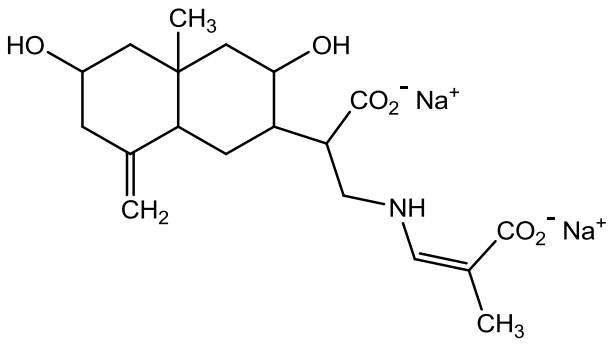
Compound Y

Which of the following will **not** be formed when compound **Y** is reacted with excess hot dilute NaOH?

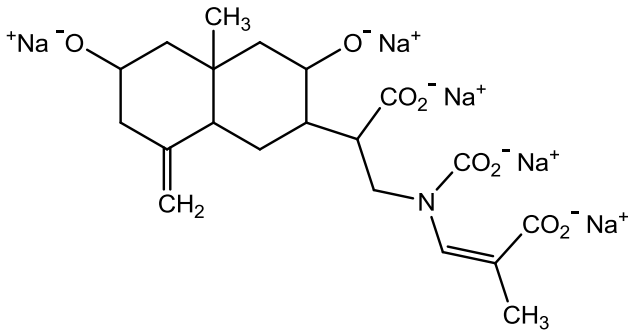
A NH_3

B Na_2CO_3

C



D



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 Which of the following is equal to one mole of the stated particles?

1 Electrons in 4.22 g of fluorine gas

2 Neutrons in 1.90 g of fluorine gas

3 Protons in 2.12 g of fluorine gas

32 Particle **X** has proton number, n.
Particle **Y** has proton number, n+1 and a charge of +2.
Particles **X** and **Y** are isoelectronic.

Which of the following statements are true?

1 **X** has a charge of +1.

2 **Y** releases more energy than **X** when an electron is added to each particle.

3 **Y** has a smaller radius than **X**.

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 The table below shows the pK_a values of some acids.

Acid	HC*l*O	HBrO	HCN
pK_a	7.46	8.70	9.21

Which of the following statements are true?

1 HBrO is more acidic than HCN.

2 BrO^- is more basic than C*l*O^-.

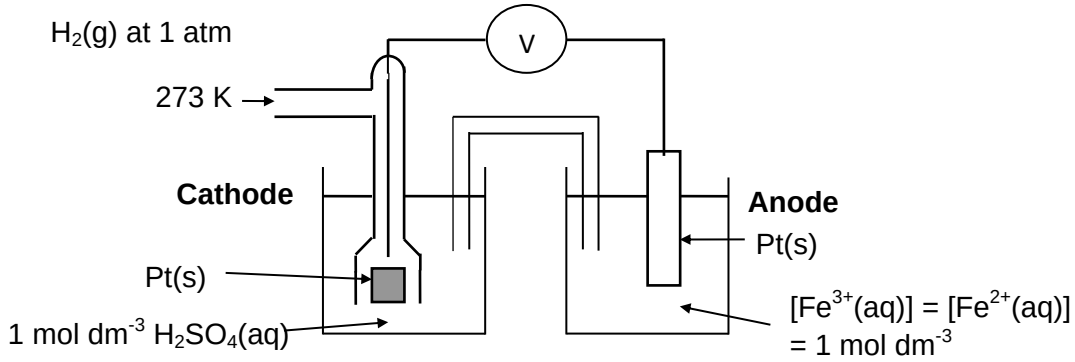
3 The maximum buffer capacity for a solution containing HCN and CN^- occurs at a pH of 9.21.

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.

34



To investigate the standard reduction potential of the Fe^{3+}/Fe^{2+} system, a student devised the following electrochemical cell. His tutor informed him that he made a number of mistakes in his diagram.

What were his mistakes?

1 The cathode and anode were wrongly assigned.

2 The conditions used for the standard hydrogen electrode were incorrect.

3 He used a platinum electrode in the Fe^{3+}/Fe^{2+} half-cell.

35 The labels of bottles containing sodium bromide and sodium iodide were accidentally removed. Which chemical tests can be used to distinguish between sodium bromide and sodium iodide?

1 Add aqueous silver nitrate followed by concentrated ammonia.

2 Add concentrated sulfuric acid.

3 Add sodium thiosulfate.

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.

36 Which statements about the chlorides of Period 3 elements are correct?

1 When one mole of PCl_5 is reacted completely with water, the resulting solution requires eight molar equivalents of NaOH for neutralisation.

2 $MgCl_2$ gives a pH below 7 when dissolved in water.

3 $AlCl_3$ reacts with water to give the colourless complex ion, $[Al(OH)_4]^-$.

37 Propane reacts with chlorine gas in the presence of ultraviolet light to form a mixture of products via free radical substitution. Which statements about this reaction are true?

1 Hexane is formed only in the termination step.

2 Homolytic fission occurs in the initiation and propagation step.

3 Chloropropane is formed only in the propagation step.

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 Thiols are organic compounds containing the −SH functional group. They are sulfur analogues of alcohols. Some common reactions undergone by thiols are shown below:

I $CH_3CH_2SH + KOH \rightarrow CH_3CH_2S^-K^+ + H_2O$

II $CH_3CH_2SH + CH_3CH_2Br \rightarrow (CH_3CH_2)_2S + HBr$

Which of the following statements are correct?

1 Thiols are stronger acids than alcohols.

2 Thiols are stronger nucleophiles than alcohols.

3 Thiols can react with Na metal

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.

39 When a current is passed through a mixture of amino acids, negatively charged species move towards the anode, while positively charged species move toward the cathode.

In a buffered solution at pH 7, which amino acid will move towards the anode?

1 $H_2NCH(CH_2COOH)COOH$

2 $H_2NCH(CH_2CH_2NH_2)COOH$

3 $H_2NCH(CH_2OH)COOH$

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 The structures of some amino acids are shown below.

Amino acid	**Formula of side chain (R in $RCH(NH_2)CO_2H$)**
Lysine	$-CH_2CH_2CH_2CH_2NH_2$
Phenylalanine	$-CH_2C_6H_5$
Valine	$-CH(CH_3)_2$
Aspartic acid	$-CH_2COOH$

The R-groups of the amino acids in a globular protein may be found facing outwards or inwards in its tertiary structure.

Which of the following options are correct?

	on the outside	**on the inside**
1	aspartic acid and lysine	valine and phenylalanine
2	phenylalanine and lysine	valine and aspartic acid
3	aspartic acid and valine	phenylalanine and lysine

~~~ END ~~~