NANYANG JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 2

CHEMISTRY 9647/01

Paper 1 Multiple Choice **21 September 2012**

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.
Write your name, class and tutor's name on the Answer Sheet in the spaces provided unless this has been done for you.

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 you choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

This document consists of **20** printed pages and **0** blank page.

[Turn over

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 and magnesium nitrate was found to be 21.25%. What mass of magnesium chloride is present in 100 g of the mixture?

A 47 g

B 51 g

C 53 g

D 56 g

2 *The use of the Data Booklet is relevant to this question.*

The successive ionisation energies, in kJ mol^{-1}, of an element **X** are given below.

870 1800 3000 3600 5800 7000 13200

What is **X**?

A $_{8}O$ **B** $_{33}As$

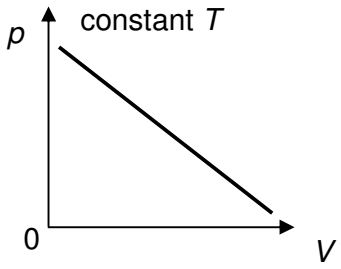
C $_{52}Te$ **D** $_{53}I$

3 Iodine and phosphorus each form a trifluoride. What are the shapes of these two molecules?

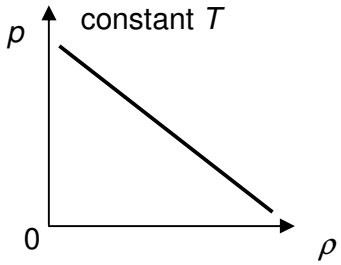
	$\underline{IF_3}$	$\underline{PF_3}$
A	trigonal planar	trigonal pyramidal
B	T-shaped	trigonal pyramidal
C	trigonal pyramidal	trigonal planar
D	T-shaped	trigonal planar

4 Which of the following diagrams correctly describes the behavior of a fixed mass of an ideal gas? (*T* is measured in K.)

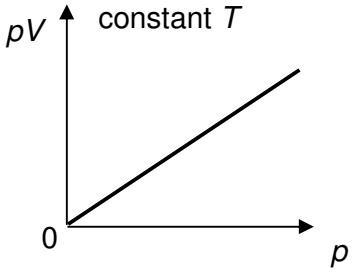
A



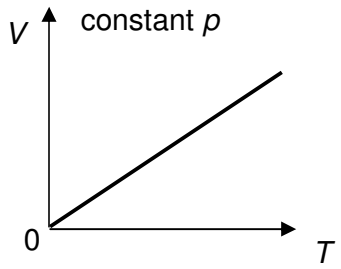
B



C



D



Questions **5** and **6** refer to the "OXO" reaction shown below.

The "OXO" reaction shown below is industrially important for making alcohols, aldehydes and carboxylic acids. For example, butanal can be synthesised from propene, C_3H_6, according to the following scheme. It can then be converted to butan-1-ol and butanoic acid.

$$\underset{\text{propene}}{CH_3CH{=}CH_2(g)} + CO(g) + H_2(g) \rightleftharpoons \underset{\text{butanal}}{CH_3CH_2CH_2CHO(g)}$$

5 The value of ΔG for this reaction is negative. What is the sign of ΔS and ΔH for the above reaction?

	ΔS	ΔH
A	+	+
B	+	−
C	−	+
D	−	−

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

Taking the bond energy for the C≡O bond in carbon monoxide to be 1077 kJ mol^{-1} and using other appropriate bond energies, what is the numerical value of ΔH for the above "OXO" reaction?

A 137 kJ mol^{-1}

B 213 kJ mol^{-1}

C 573 kJ mol^{-1}

D 623 kJ mol^{-1}

7 The radioactive decay is a first order reaction. If the rate of decay of a radioactive isotope decreases from 200 counts per minute to 25 counts per minute after 21.6 hours, what is its half-life?

A 2.4 hours

B 6.5 hours

C 7.2 hours

D 7.8 hours

8 Which of the following statements correctly explains why a small increase in temperature leads to a significant increase in the rate of a gaseous reaction?

A The average kinetic energy of the molecules is slightly greater at a higher temperature.

B The proportion of molecules with any given energy increases.

C The frequency of collisions between molecules is greater at a higher temperature.

D The frequency of collisions between molecules with kinetic energy greater than the activation energy is greater at a higher temperature.

9 An equilibrium can be represented by the following equation:

$$\mathbf{P}(aq) + \mathbf{Q}(aq) \rightleftharpoons 2\mathbf{R}(aq) + \mathbf{S}(aq)$$

In a certain mixture, the equilibrium concentration of **Q** is 10 mol dm^{-3}.

What will be the new equilibrium concentration of **Q** if 5 mol of pure **Q** is dissolved in the mixture?

A 15 mol dm^{-3}

B between 10 mol dm^{-3} and 15 mol dm^{-3}

C 10 mol dm^{-3}

D between 5 mol dm^{-3} and 10 mol dm^{-3}

10 Which of the following correctly lists 0.10 mol dm^{-3} solutions of HCl, KCl, NH_4Cl, KOH and KCN in order of increasing pH?

A HCl, KCl, KCN, NH_4Cl, KOH

B HCl, NH_4Cl, KCl, KCN, KOH

C HCl, KCl, NH_4Cl, KCN, KOH

D KCl, KCN, KOH, HCl, NH_4Cl

11 Thorium hydroxide, $Th(OH)_4$, is a sparingly soluble salt. Which of the following shows the correct expression of its molar solubility s (mol dm^{-3}) in terms of its solubility product K_{sp}?

A $s = (K_{sp})^{1/5}$

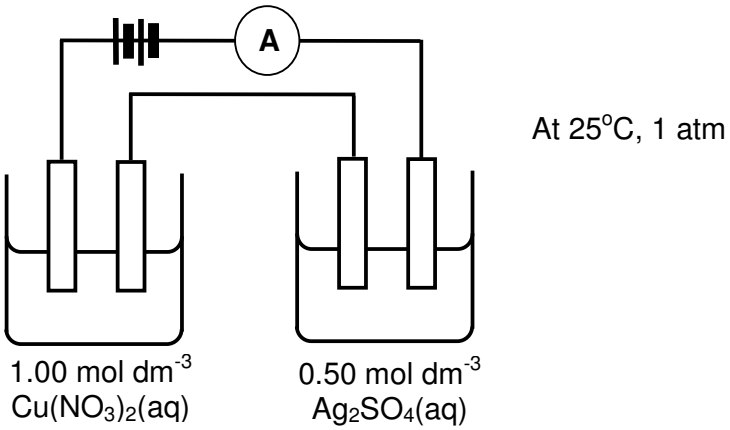
B $s = (K_{sp}/4)^{1/2}$

C $s = (K_{sp})^{1/5}/256$

D $s = (K_{sp}/256)^{1/5}$

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

Using inert electrodes, a current was passed through two beakers containing aqueous silver sulfate and aqueous copper(II) nitrate, connected in series under standard conditions.



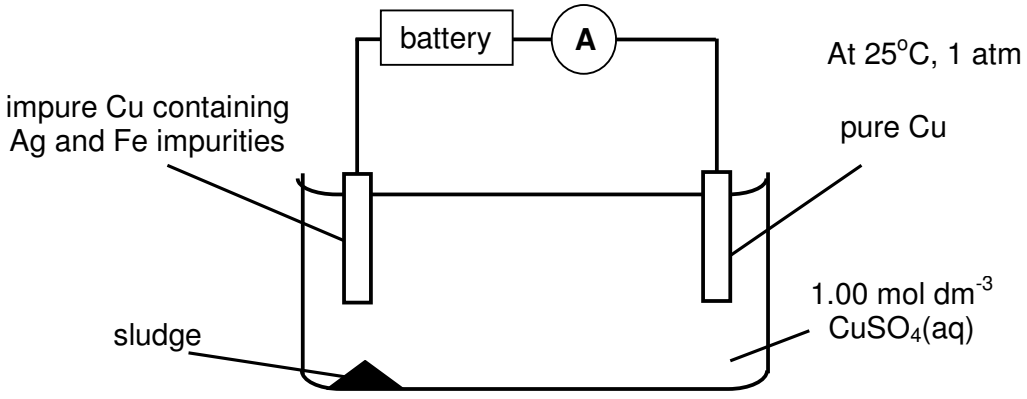
What is the ratio of the mass of silver to copper deposited after the current was passed for t minutes?

A 0.59 **B** 0.85

C 1.70 **D** 3.40

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

The circuit shown in the diagram was set up.



What are the products formed at the anode and cathode and what is the substance present in the sludge after some time?

	anode	cathode	sludge
A	Cu^{2+}	Cu	Ag
B	Fe^{2+}	Cu^{2+}	Ag
C	Ag^{+}, Fe^{2+}	Cu^{2+}	Zn
D	Cu^{2+}, Fe^{2+}	Cu	Ag

14 On descending Group II from magnesium to barium, which of the following statements is true?

A The enthalpy change of hydration of the M^{2+} ion becomes more exothermic.

B The first ionisation energy increases.

C The nitrates is less easily decomposed by heat to give brownish fumes.

D The solubility of the Group II oxides decreases.

15 What is observed when aluminium chloride is added to excess water?

	solubility in water	pH of resulting solution
A	insoluble	7.0
B	very slightly soluble	6.5
C	dissolves	5.0
D	dissolves	3.0

16 Which of the following compounds has the highest melting point?

A NaCl

B $MgCl_2$

C $AlCl_3$

D $SiCl_4$

17 Both aqueous bromine and aqueous chlorine appear as yellow solutions. Which of the following reagents can be used to distinguish the two solutions?

A aqueous chlorine

B aqueous sodium chloride

C aqueous sodium thiosulfate

D aqueous iron(II) sulfate, followed by aqueous sodium hydroxide

18 In the laboratory, there are three bottles labeled **A**, **B** and **C**. Each bottle contains one of the following reagents: $CaCl_2(aq)$, $FeCl_2(aq)$ and $AgNO_3(aq)$.
The tests were carried out using these reagents and the results were summarised in the table below:

Tests	Observations
Mixing reagents **A** and **B**, followed by addition of $NH_3(aq)$	A white ppt soluble in $NH_3(aq)$
Mixing reagents **A** and **C**, followed by addition of $NH_3(aq)$	A grey precipitate insoluble in $NH_3(aq)$

What are the identities of the reagents **A**, **B** and **C**?

	A	**B**	**C**
A	$CaCl_2$	$AgNO_3$	$FeCl_2$
B	$FeCl_2$	$AgNO_3$	$CaCl_2$
C	$AgNO_3$	$FeCl_2$	$CaCl_2$
D	$AgNO_3$	$CaCl_2$	$FeCl_2$

19 Letters written on paper using aqueous ammonium thiocyanate are invisible until turned blood-red by brushing the paper with aqueous iron(III) chloride. If the ammonium thiocyanate is first made alkaline, the letters are orange and less clear.

Which of the following substances, when formed on the paper in these reactions, best explains these observations?

	with aqueous ammonium thiocyanate	*with alkaline aqueous ammonium thiocyanate*
A	Fe-NH_3 complex	$Fe(OH)_3$
B	Fe-CNS^- complex	Fe-NH_3 complex
C	Fe-CNS^- complex	$Fe(OH)_3$
D	Fe-CNS^- complex	Fe-OH^- complex

20 The table shows the possible oxidation states of five d-block elements in the Periodic Table. (The elements are represented by letters which are **not** their symbols.)

element	*possible oxidation numbers*						
P	–	–	3	–	–	–	–
Q	–	2	3	4	–	–	–
R	1	2	3	4	5	–	–
S	–	2	–	4	5	6	7

Which of the following ions is likely to exist?

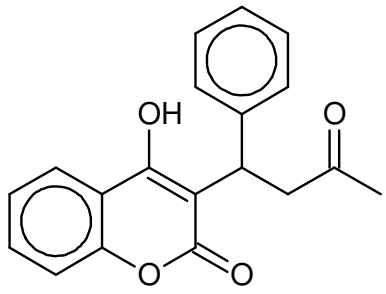
A PO_2^+

B QO_3^-

C RO_4^{2+}

D SO_2^{2+}

21 *Warfarin* is used as a rat poison.



Warfarin

How many sp^2 hybridised carbon atoms are present in the *Warfarin* molecule?

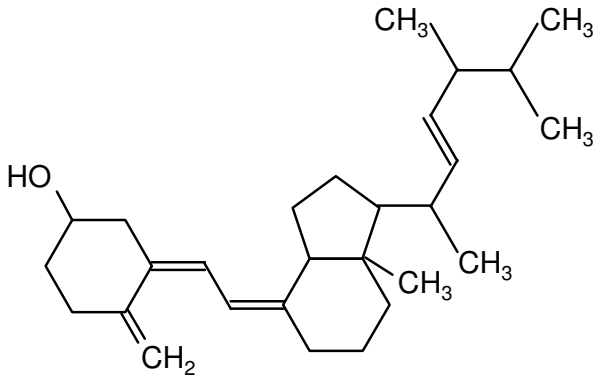
A 4

B 12

C 14

D 16

22 The structure of vitamin D2 is shown below.



When it is completely reacted with hydrogen in the presence of a palladium catalyst at room temperature, how many chiral centres does the product molecule possess?

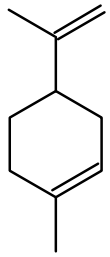
A 7

B 8

C 9

D 10

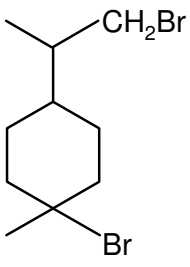
23 Limonene is an oil formed in the peel of citrus fruits.



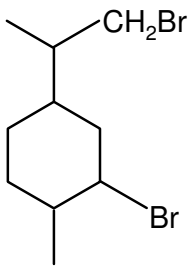
limonene

Which of the following is the major product formed when hydrogen bromide reacts with limonene at room temperature?

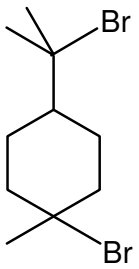
A



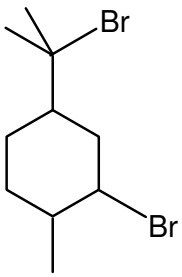
B



C



D



24 A sample of ethylbenzene is quantitatively oxidised to the corresponding carboxylic acid.

What is the mass of product formed from 1.00 g of ethylbenzene?

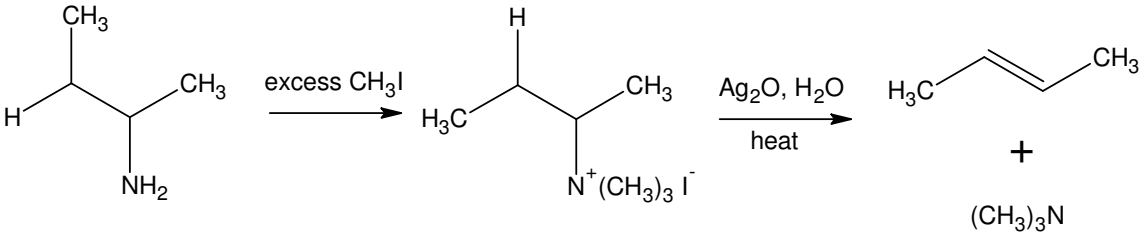
A 1.15 g

B 1.28 g

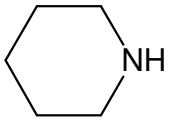
C 1.32 g

D 1.38 g

25 The Hofmann elimination is a process where an amine undergoes treatment with excess methyl iodide to form a tertiary amine intermediate followed by treatment with silver oxide, water and heat to form an alkene.



What is the structure of the alkene formed when a cyclic amine, piperidine, undergoes the Hofmann elimination?

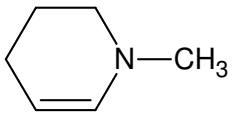


Piperidine

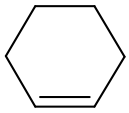
A $CH_2=CHCH_2CH_2CH_2N(CH_3)_2$

B $CH_2=CHCH_2CH_2CH_3$

C



D



26 When sodium iodide in propanone is added to an optically active sample of 2-bromobutane, a sodium bromide precipitate formed after 13 minutes upon heating.

$$NaI + CH_3CHBrCH_2CH_3 \longrightarrow CH_3CHICH_2CH_3 + NaBr(s)$$

The experiment was repeated several times and the rate equation was found to be

$$Rate = k[CH_3CHBrCH_2CH_3][NaI]$$

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

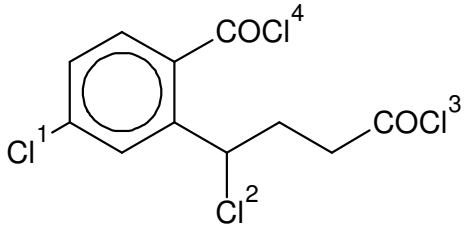
A A racemic mixture is formed.

B The reaction involves nucleophilic substitution.

C The reaction is bimolecular.

D A similar experiment, using 1-bromobutane, will produce precipitate in less than 13 minutes.

27 The following compound contains 4 chlorine atoms (labelled 1, 2, 3 and 4).



What is the relative order of **increasing** ease of hydrolysis of the chlorine atoms?

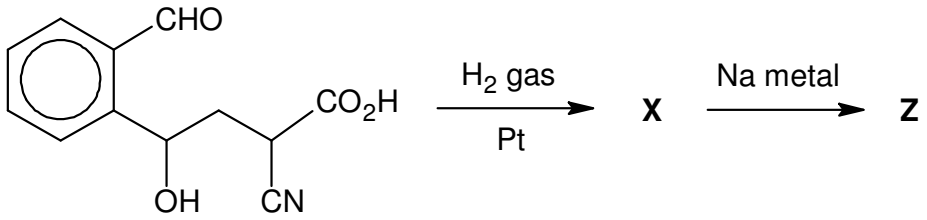
A 1, 2, 3, 4

B 2, 1, 3, 4

C 1, 2, 4, 3

D 2, 1, 4, 3

28 Compound **Z** can be obtained via the 2-step synthesis from compound **V**.



V

What is the change in gas volume if 96 dm^3 of H_2 gas was reacted with one mole of compound **V**, followed by excess sodium metal, at room conditions?

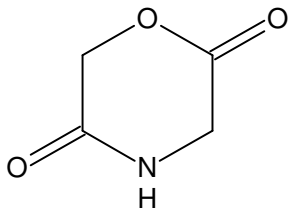
A Gas volume contracted by 60 dm^3

B Gas volume contracted by 36 dm^3

C Gas volume expanded by 60 dm^3

D Gas volume expanded by 36 dm^3

29 Which of the following compound can be used, in a 1-step conversion, to produce the following cyclic structure?



A $HO_2CCH_2NH_2$ and HO_2CCH_2OH

B $HO_2CCH_2CONHCH_2OH$

C $ClOCCH_2COCl$ and H_2NCH_2OH

D $ClOCCH_2OH$ and $H_2NCH_2CO_2H$

30 The thermal decomposition of calcium ethanoate produces its metal carbonate and a carbonyl compound.

$$(CH_3CO_2)_2Ca \rightarrow CaCO_3 + (CH_3)_2CO$$

When a mixture of calcium ethanoate and calcium methanoate was heated, a mixture of three carbonyl compounds **X**, **Y** and **Z** were obtained. Both **X** and **Y** give a silver mirror with Tollen's reagent but not **Z**. Both **X** and **Z** give yellow precipitate in aqueous alkaline iodine but not **Y**.

Based on the above, which of the following statements are **incorrect**?

A Only **X** and **Y** can decolourise aqueous potassium manganate(VII).

B The ratio of **X** to **Y** to **Z** formed is 2:1:1.

C Only **X** reacts with HCN to produce an optically active product.

D All three compounds can form an orange precipitate with 2,4-DNPH.

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 10 cm^3 of a gaseous hydrocarbon **X** is mixed with 100 cm^3 oxygen and ignited. After the reaction the gases produced are shaken with aqueous KOH solution. The final volume of gases is 25 cm^3. Which of the following hydrocarbons could be **X**?
(All volumes are measured at room temperature and pressure.)

1 C_4H_8

2 C_5H_{10}

3 C_6H_6

32 1 dm^3 of gas **X** weighs 1 g and 1 dm^3 of gas **Y** weighs 5 g under the same conditions of temperature and pressure. Which of the following statements are correct?

1 The ratio of the M_r of **X** to **Y** is 1:5.

2 The average velocity of the molecules in gas **X** and gas **Y** are the same at the same temperature.

3 The number of molecules of **Y** in 1 dm^3 is five times the number of molecules of **X** in 1 dm^3.

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 In the reaction between iodide and peroxodisulfate, iron(III) is used as a catalyst. Which of the statements are **incorrect**?

1 The rate of both the forward and backward reaction increases to the same extent, but the rate constant remains the same.

2 One of the equations involve: $2Fe^{3+} + 2S_2O_3^{2-} \rightarrow 2Fe^{2+} + S_4O_6^{2-}$.

3 This reaction is an example of a homogeneous catalysis.

34 Ammonia is manufactured in the Haber process.

$$N_2\,(g) + 3H_2\,(g) \rightleftharpoons 2NH_3\,(g)\ \Delta H^{\ominus} = -92\ kJ\ mol^{-1}$$

Given that K_p for the above reaction is 3.375 at T K, which of the following statements involving the reaction is correct?

1 The partial pressure of H_2 (g) at equilibrium at T K can be expressed as $\frac{2}{3}\left(P_{NH_3}\right)^{2/3}\left(P_{N_2}\right)^{-1/3}$.

2 When equilibrium is established, temperature, T K, is given by $T = \frac{\Delta H}{\Delta S}$.

3 When pressure is increased, the yield of ammonia and the equilibrium constant increases.

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.

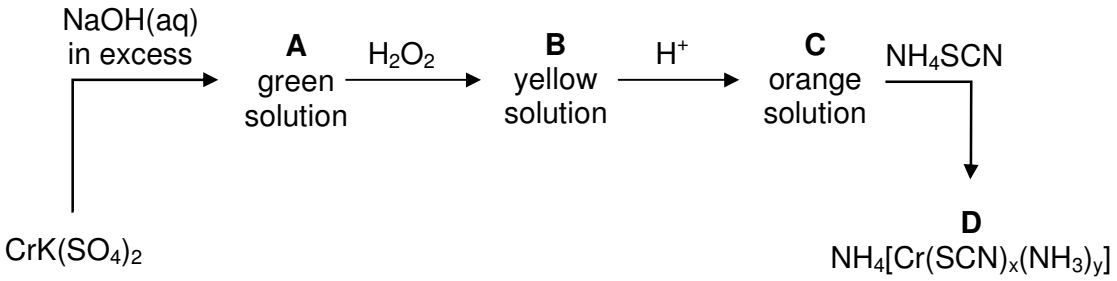
35 The Group II metals have higher melting points than the Group I metals. Which of the following factors could contribute towards the higher melting points?

1 There are smaller interatomic distances in the metallic lattices of the Group II metals.

2 Two valence electrons are available from each Group II metal atom for bonding the atom into the metallic lattice.

3 Group II metals have higher first ionization energies.

36 Chromium and its compounds undergo the following reactions.



D has the following composition by mass: Cr, 15.5%; S, 38.1%; N, 29.2%

Which of the following can be deduced from the above reaction scheme?

1 The values of x and y in **D** are 4 and 2 respectively.

2 The types of reactions that occur are ligand exchange and redox only.

3 The formula of **A** is $Cr(OH)_2(H_2O)_6$.

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

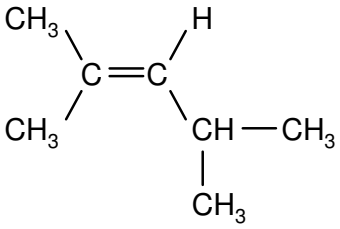
A	B	C	D
1, **2** and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

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

37 A hydrocarbon, on heating with an excess of hot concentrated acidic $KMnO_4(aq)$, produces CH_3COCH_3 and $(CH_3)_2CHCO_2H$ as the only organic products.

What could the hydrocarbon be?

1



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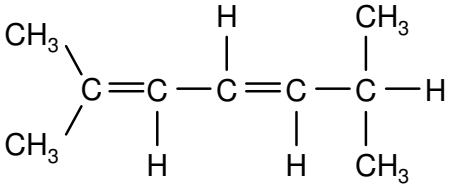
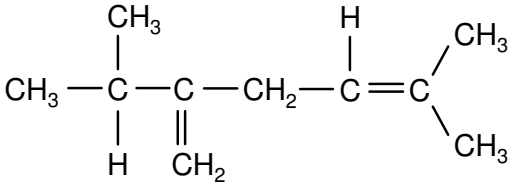
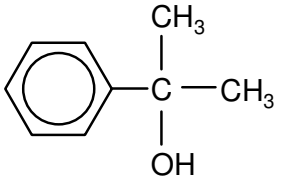
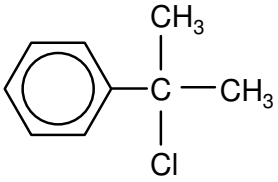


3



38 Which reagents can be used to distinguish between the following compounds?





1 PCl_5

2 $Na_2Cr_2O_7$

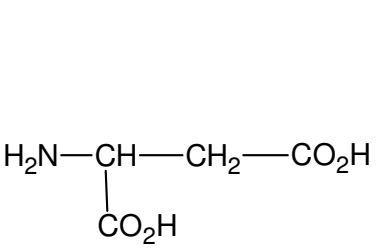
3 $NaHCO_3$

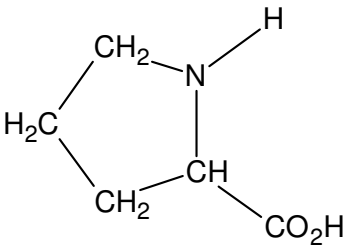
The responses **A** to **D** should be selected on the basis of

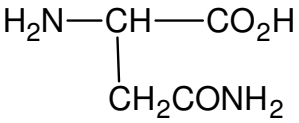
A	B	C	D
1, **2** and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

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

39 The following are structures of 3 amino acids.

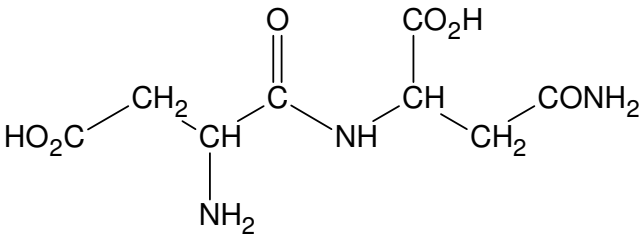




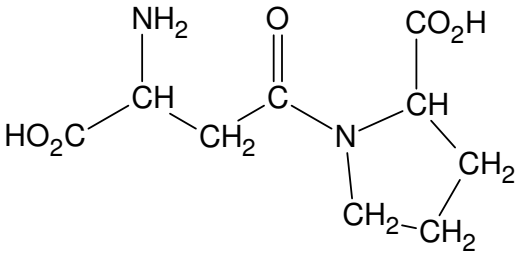


Which of the following represents dipeptides formed from these amino acids?

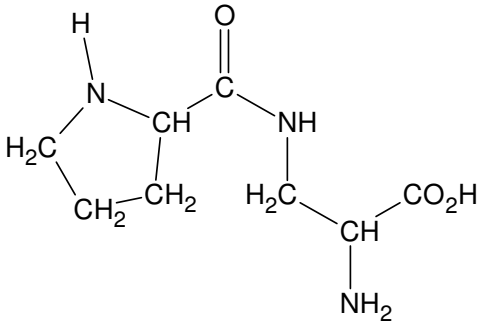
1



2



3

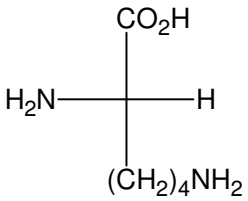


The responses **A** to **D** should be selected on the basis of

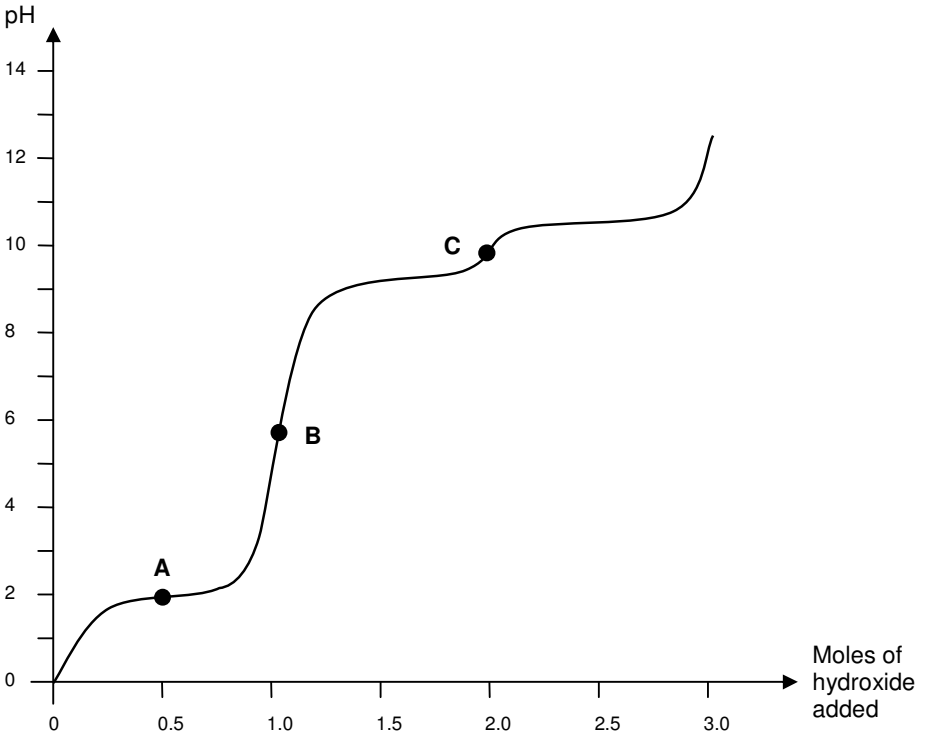
A	B	C	D
1, **2** and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

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

40 Lysine is an essential amino acid found in the body. It has three pK_a values associated with it: 2.2, 9.0 and 10.5



When one mole of protonated lysine was titrated against hydroxide ions, the following pH curve is obtained:



Which of the following statements are true with respect to the curve above?

1 Equal amounts of $H_3N^+CH(CO_2H)(CH_2)_4NH_3^+$ and $H_3N^+CH(CO_2H)(CH_2)_4NH_2$ are present at point **A**.

2 The major species present at point **C** has no net charge.

3 The major species present at point **B** will migrate towards the cathode of an electrolytic cell.