Catholic Junior College

JC 2 Preliminary Examinations

Higher 2

CANDIDATE NAME	
CLASS	**2T**

CHEMISTRY 9729/01

Paper 1 Multiple Choice **15 September 2023**

1 hour

Additional Materials: Multiple Choice Answer Sheet
Data Booklet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, class and NRIC/FIN number on the Answer Sheet in the spaces provided.

There are **thirty** 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.

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

This document consists of **16** printed pages.

1 What volume of air is required for the complete combustion of 1.0 dm^3 of octane vapour, $C_8H_{18}(g)$, in a car engine? (Air contains 20% oxygen by volume.)

A 2.5 dm^3 **B** 12.5 dm^3 **C** 62.5 dm^3 **D** 125.0 dm^3

2 The ionisation energies, in kJ mol^{-1}, of three elements are given in the table.

	1st ionisation energy	2nd ionisation energy	3rd ionisation energy
Ne	2080	3950	6150
Na	494	4560	6940
Mg	736	1450	7740

Which statement(s) about these ionisation energies is/are correct?

1 Ne has the greatest 1st ionisation energy of the three elements because its electrons experience the most interelectronic repulsion.

2 Mg has the lowest 2nd ionisation energy of the three elements because the electron being removed experiences the greatest shielding effect.

3 There is a large increase from the 2nd to 3rd ionisation energy of Na because the electron is being removed from the next inner subshell.

A 1 and 2 only **B** 2 only **C** 1 and 3 only **D** 3 only

3 Equimolar amounts of the liquids hexane, $CH_3(CH_2)_4CH_3$, and triethylamine, $(CH_3CH_2)_3N$, are mixed together at 20 °C. The original intermolecular forces are disrupted and stronger intermolecular forces between $CH_3(CH_2)_4CH_3$ and $(CH_3CH_2)_3N$ are formed simultaneously.

The boiling point of hexane is 69 °C. The boiling point of triethylamine is 90 °C.

Which row is correct?

	initial temperature of mixture	boiling point of mixture
A	above 20 °C	below 69 °C
B	below 20 °C	below 69 °C
C	below 20 °C	above 90 °C
D	above 20 °C	above 90 °C

4 In the gaseous state, phosphorus(V) chloride exists as a molecule with the formula PCl_5. However, when it is a solid, it is ionic with the formula $PCl_4^+PCl_6^-$.

Which one of the following statements is correct?

A The bond angle in PCl_4^+ is smaller than that in PCl_6^-.
B There is a dative covalent bond in PCl_6^-.
C The P atom in PCl_4^+ has an expanded octet.
D There is a net dipole moment in PCl_5.

5 Which pairs of compounds contain a polar and a non-polar molecule?

1 CO_2, H_2O
2 SO_2, NO_2
3 CH_2Cl_2, $SiCl_4$

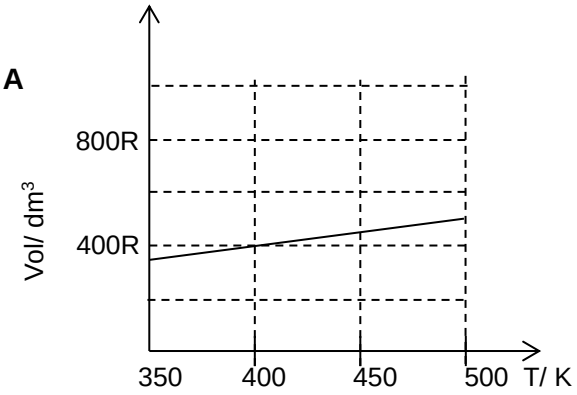
A 1, 2 and 3 **B** 1 and 3 only **C** 2 and 3 only **D** 1 only

6 A gaseous dimer, $\mathbf{X}_2$, dissociates into its gaseous monomer, **X**, at 400 K and 1 atm pressure. Dissociation is complete at 450 K.

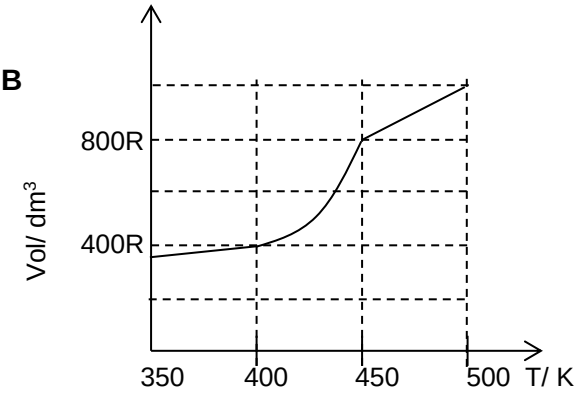
$$\mathbf{X}_2\,(g) \rightarrow 2\mathbf{X}\,(g)$$

Which of the following graphs shows the variation of volume with temperature when one mole of $\mathbf{X}_2$ is heated from 350 K to 500 K at a constant pressure of 1 atm? Assume that the gases behave ideally. ($R = 0.082\ mol^{-1}\ dm^3\ atm\ K^{-1}$)

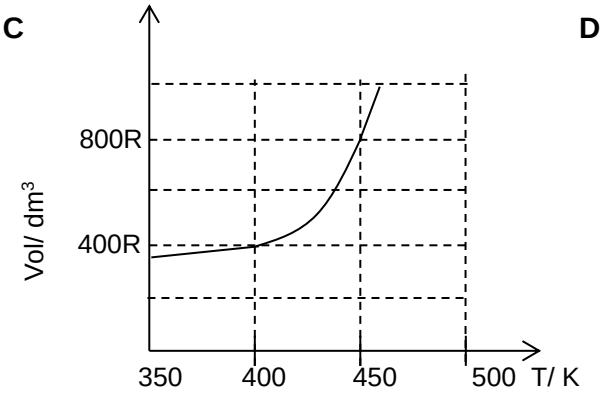
A



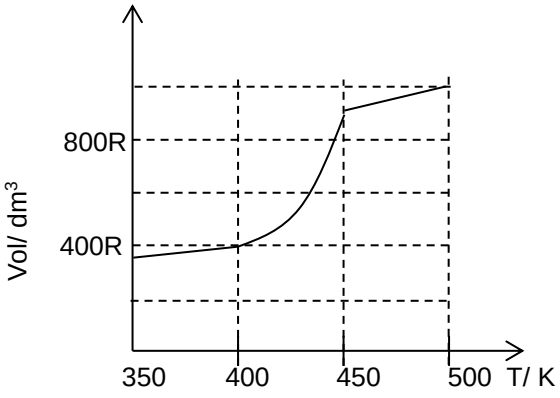
B



C



D



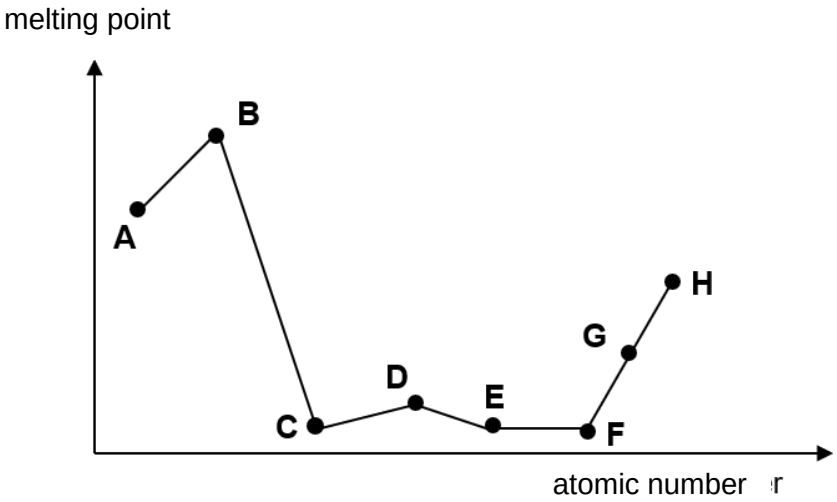
7 *Use of the Data Booklet is relevant to this question.*

At 400 K, the following species behave as ideal gases: H_2, CH_4, NO_2, Ar. 5.00 g of each of these gases is put separately into a gas syringe kept at 400 K.
The volume of each gas is adjusted to be the same, and pressure is measured.

Which gas will have the lowest pressure?

A H_2
B CH_4
C NO_2
D Ar

8 The graph below shows the variation in the melting point for 8 consecutive elements in the Periodic Table, all with atomic number ≤ 20.



What can be deduced from the graph?

A The ions of **A** and **E** are isoelectronic.

B The chlorides become less acidic from **A** to **C**.

C When the oxide of **C** is added to water, the resulting solution has a pH greater than 7.

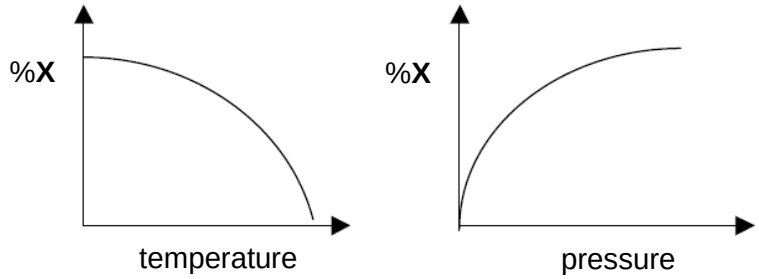
D The oxide of **A** reacts with excess aqueous sodium hydroxide to form a soluble complex.

9 Which of the following processes are endothermic?

1 $N_2(g) + O_2(g) \rightarrow 2NO(g)$
2 $O^-(g) + e^- \rightarrow O^{2-}(g)$
3 $C(s) + O_2(g) \rightarrow CO_2(g)$

A 1 only
B 1 and 2 only
C 2 and 3 only
D 1, 2 and 3

10 The graphs below show how the percentage of reactant **X**(g) in an equilibrium varies with changes in temperature and pressure.



Which of the following conclusions about the above equilibrium can be drawn from this information?

A The forward reaction is exothermic.

B Addition of a catalyst will have a greater effect on the rate of reverse reaction than the rate of forward reaction.

C The equation for the reaction could be in the form of W(g) + **X**(g) ⇌ 2Y(g) + Z(g).

D The value of K_c decreases as pressure increases.

11 The rate of removal of a new drug from the body is a first-order reaction. 75% of the initial drug present in a patient is removed over 5.4h.

How much time will it take to remove 90% of this drug from the body?

A 6.75h **B** 8.10h **C** 8.97h **D** 10.8h

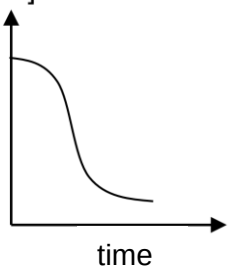
12 The chlorite-tetrathionate reaction, in which the chlorite ion is one of the reactants, has been studied. One of the products, $H^+(aq)$, catalyses the reaction.

$$2S_4O_6^{2-} + 7ClO_2^- + 6H_2O \rightarrow 8SO_4^{2-} + 7Cl^- + 12H^+$$

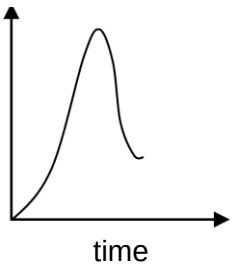
tetrathionate chlorite

Which graph best describes the above reaction?

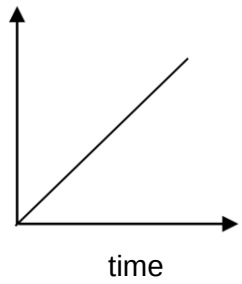
A



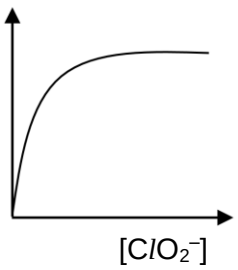
B



C



D



13 Metal sulfides are generally insoluble. K_{sp} values for copper sulfide and zinc sulfide at 298 K are listed in the table below.

metal sulfide	colour	K_{sp} / mol^2dm^{-6}
CuS	black	6.3×10^{-36}
ZnS	white	1.6×10^{-24}

When aqueous copper sulfate is added to white solid of ZnS, black precipitate of CuS is observed according to the following reaction.

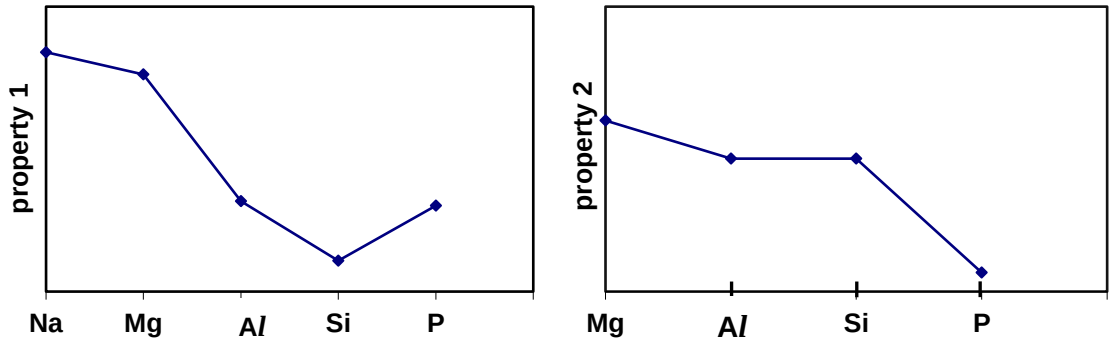
$$ZnS(s) + Cu^{2+}(aq) \rightleftharpoons CuS(s) + Zn^{2+}(aq)$$

What is the equilibrium constant, K_c, for the reaction above?

A 1.0×10^{-59} **B** 3.9×10^{-12}

C 5.0×10^{5} **D** 2.5×10^{11}

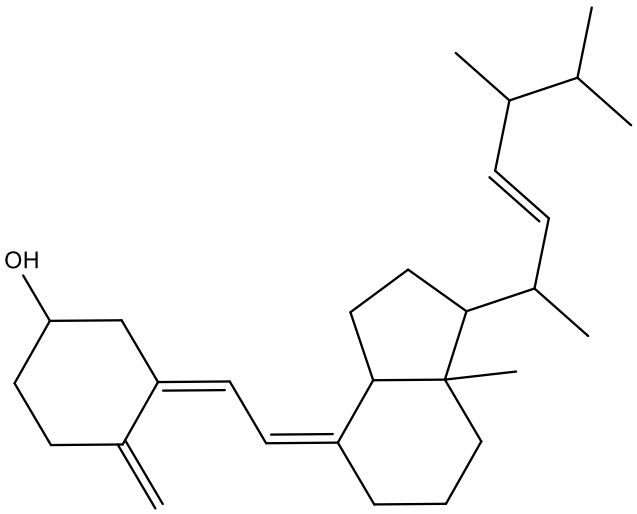
14 The graphs below show the variation of two properties of some period 3 elements and/or their compounds.



Which of the following correctly describes properties 1 and 2?

	property 1	property 2
A	atomic radius of the elements	electrical conductivity of the elements
B	melting point of the chlorides	pH of oxides when added to water
C	melting point of the elements	first ionisation energies of the elements
D	electrical conductivity of elements	pH of chlorides when added to water

15 The structure of vitamin D2 is shown below.

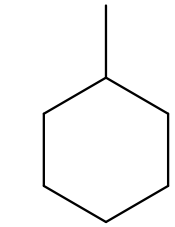


vitamin D2

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?

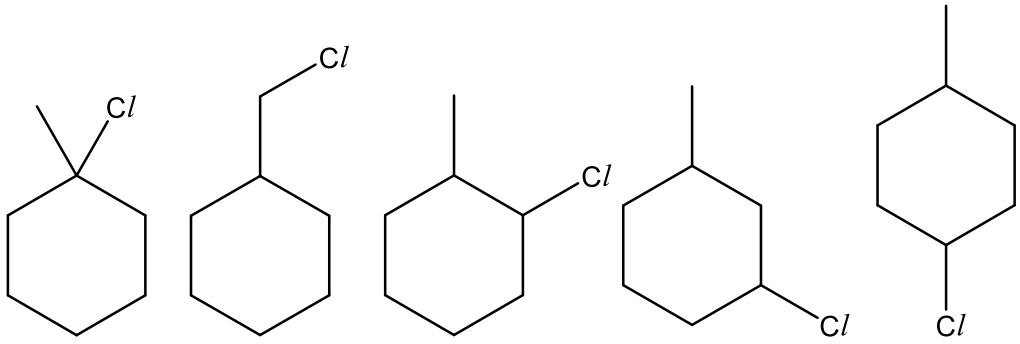
A 7 **B** 8 **C** 9 **D** 10

16 Methylcyclohexane was reacted with limited chlorine in the presence of *uv* light.



methylcyclohexane

Assuming that only mono-chlorination takes place, and the reaction occurs at the same rate at all carbon atoms, what is the ratio of the products obtained below?



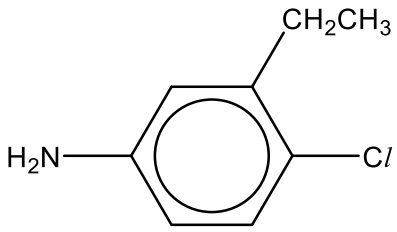
A	1	:	3	:	4	:	4	:	2
B	1	:	3	:	2	:	2	:	2
C	1	:	1	:	4	:	4	:	2
D	1	:	3	:	4	:	2	:	1

17 Compound **S** upon reaction with hot acidified potassium manganate(VII) yields CH_3COCH_3, $CH_3COCH_2CH_2CO_2H$ and $CH_3CH_2CO_2H$.

Which compound could be **S**?

A $CH_3CH=C(CH_3)CH_2CH_2C(CH_3)=CHCH_2CH_3$
B $(CH_3)_2C=CHCH_2CH_2C(CH_3)=CHCH_2CH_3$
C $(CH_3)_2C=CHCH_2CH_2C(CH_2OH)=CHCH_3$
D $(CH_3)_2C=C(CH_3)CH_2C(CH_3)=CHCH_2CH_3$

18 Which synthetic route is most likely to lead to the most successful synthesis of the following product from benzene?



A nitration, chlorination, alkylation, reduction
B nitration, alkylation, reduction, chlorination
C nitration, reduction, alkylation, chlorination
D alkylation, nitration, chlorination, reduction

19 The following two reactions occur under identical conditions and proceed via the same mechanism. It was found that reaction 1 occurs faster than reaction 2.

reaction 1: $CH_3CHBrCH_3 + NaCN \rightarrow CH_3CH(CN)CH_3 + NaBr$
reaction 2: $CH_3CHBrCH_3 + NaI \rightarrow CH_3CHICH_3 + NaBr$

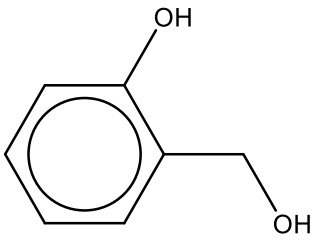
What could be the most likely explanation?

A The C–I bond is a stronger bond than the C–Br bond.
B The C–N bond is a stronger bond than the C–I bond.
C The CN^- ion is a stronger nucleophile than the I^- ion.
D The Br^- ion is a stronger nucleophile than the I^- ion.

20 Which of the following halogenoalkanes will undergo an S_N1 reaction and produce a white precipitate when $AgNO_3(aq)$ is added to it?

A 1-chloroethane
B 1-bromoethane
C 2-chloro-2-methylpropane
D 2-iodo-2-methylpropane

21 Saligenin is a white solid with the following structure.

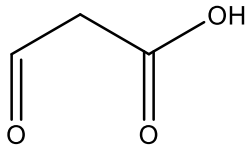
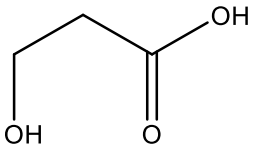
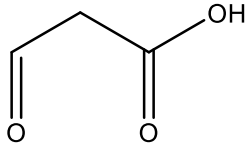
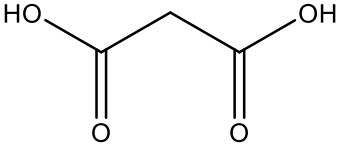
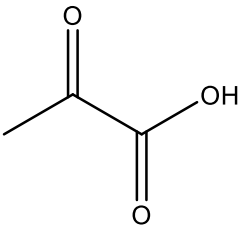
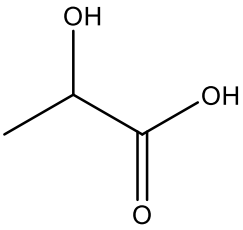
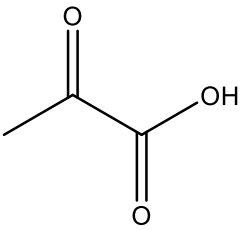
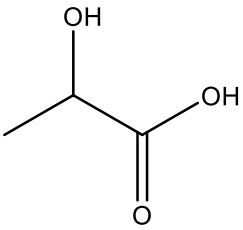


saligenin

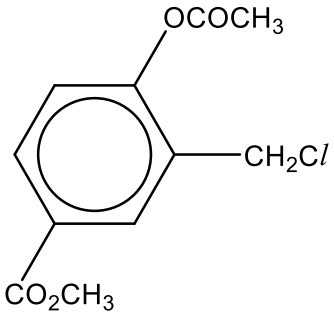
Separate samples of one mole of saligenin each are mixed with Br_2(aq) and NaOH(aq) respectively. How many moles of Br_2(aq) and NaOH(aq) will react?

	Br_2(aq)	NaOH(aq)
A	0	1
B	1	2
C	2	2
D	2	1

22 Pyruvic acid, $C_3H_4O_3$, contains a carboxylic acid functional group and another functional group that forms an orange precipitate with 2,4-dinitrophenylhydrazine. Pyruvic acid undergoes reduction to form lactic acid. But during this reduction reaction, the acid functional group does not react. Which one of the following rows gives the correct details of this reaction?

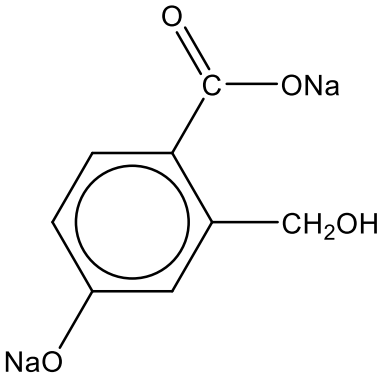
	suggested structure of pyruvic acid	reagents and conditions	suggested structure of lactic acid
A		$LiAlH_4$ in dry ether	
B		$NaBH_4$ in methanol	
C		$LiAlH_4$ in dry ether	
D		$NaBH_4$ in methanol	

23 Which one of the following represents the organic product when an excess of hot aqueous sodium hydroxide is added to compound **R**?

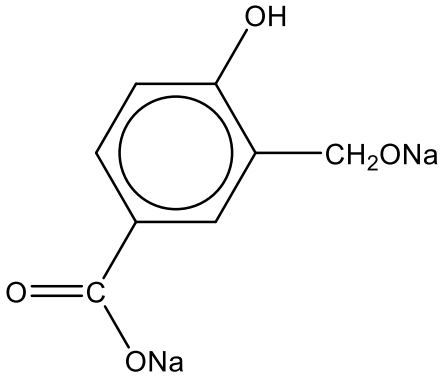


R

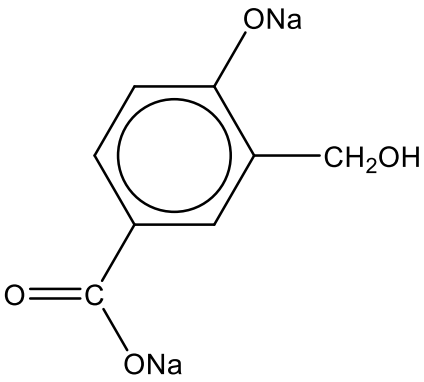
A



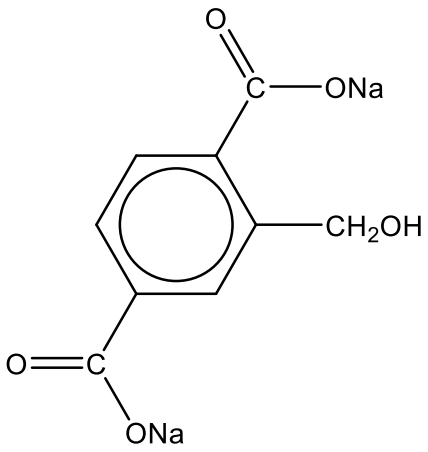
B



C

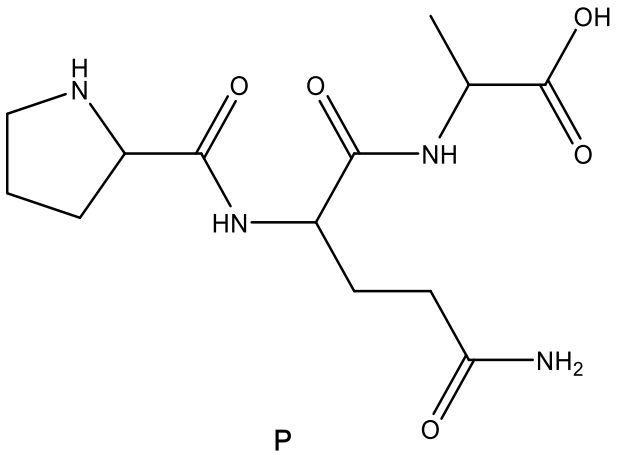


D



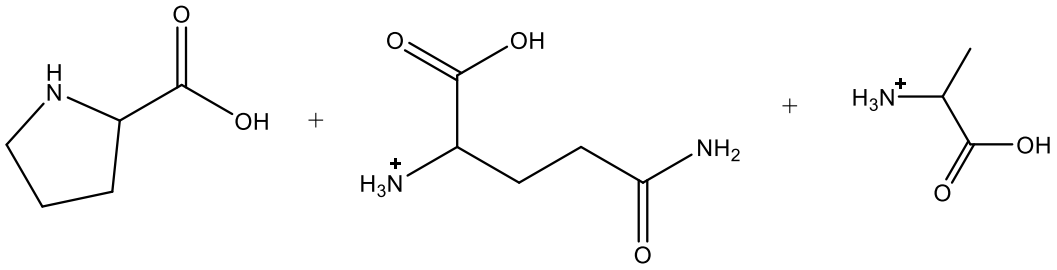
24 The tripeptide **P** is made by reacting three different amino acids together.

When **P** is reacted with hot HC*l*(aq), what will be the most likely organic product(s) formed?

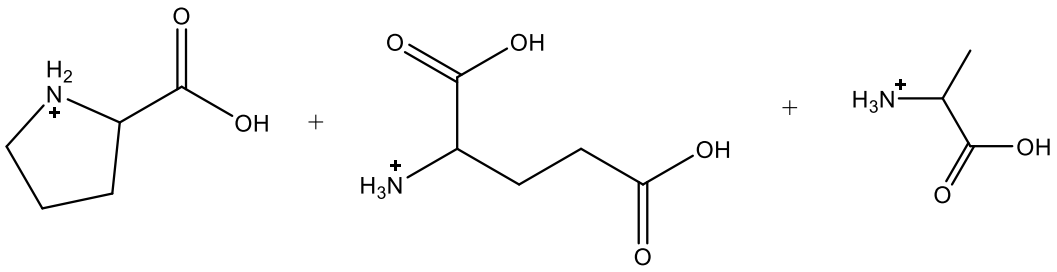


P

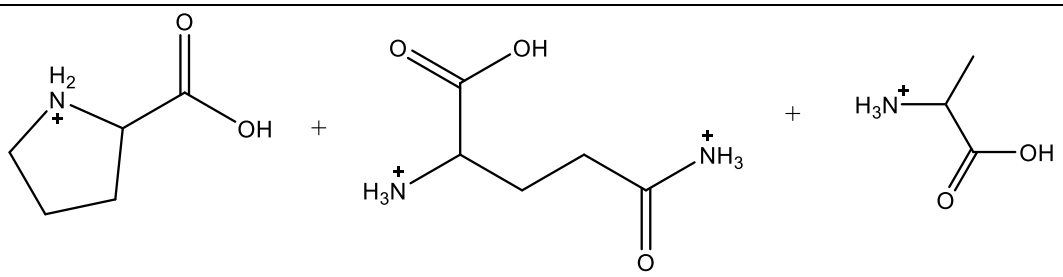
A



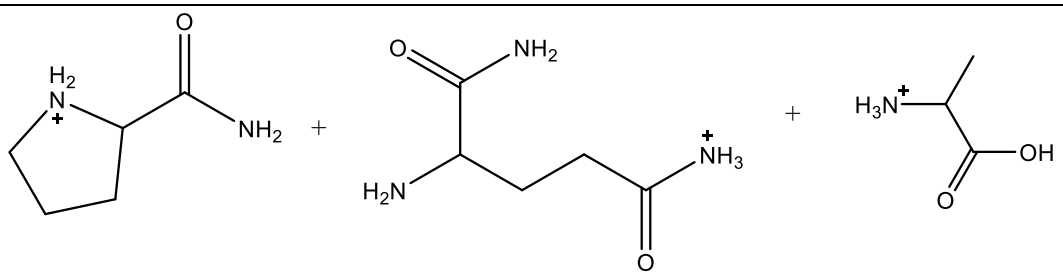
B



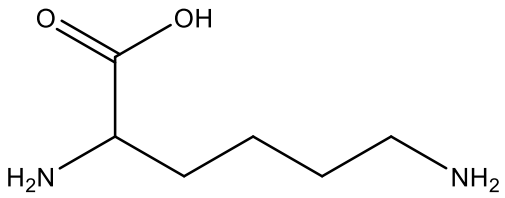
C



D

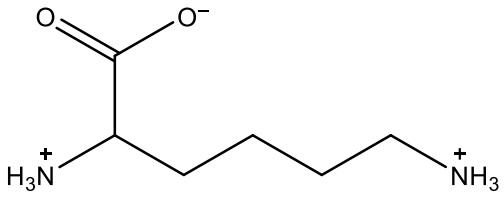
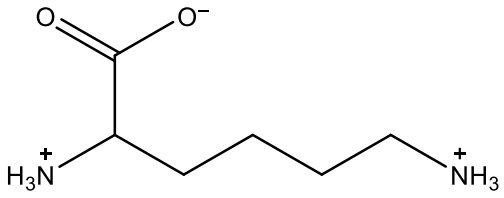
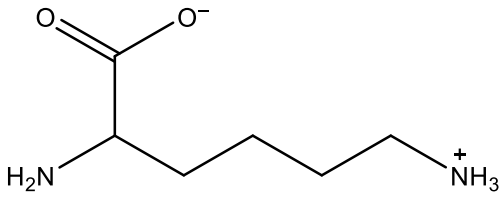


25 Lysine is an amino acid with pK_a values 2.16, 9.06 and 10.54.



lysine

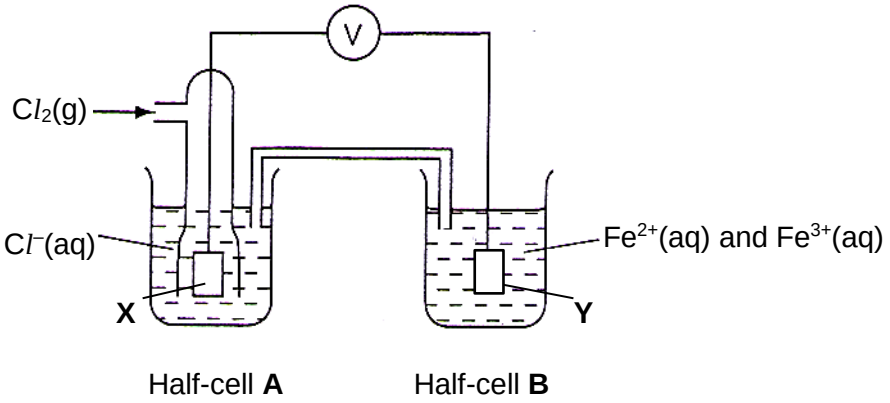
Which of the following show the correct predominant structure when lysine is in an aqueous solution at the respective pH?

	pH	predominant structure
1	3	
2	7	
3	10	

A 1 only **B** 2 only **C** 1 and 3 only **D** 1, 2 and 3

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

The cell shown in the diagram is set up under standard conditions where **X** and **Y** are platinum electrodes.



Which of the following statements is correct?

A Changing **Y** to Fe in half-cell **A** will not affect $E^{\ominus}_{cell}$.
B The voltmeter will show a reading of about 2.13V.
C The electrons will flow from **Y** to **X** through the voltmeter.
D **X** will be the negative electrode.

27 An aqueous solution of copper(II) salt is electrolysed between copper electrodes, using a constant current. What affects the mass of copper deposited on the cathode?

1 the time taken
2 the concentration of solution
3 the size of the electrodes

A 1, 2 and 3
B 1 and 2 only
C 2 and 3 only
D 1 only

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

In the electrolysis of molten lead(II) bromide, 2.072 g of lead is liberated when 1940 coulombs of electricity is passed through molten lead(II) bromide. Which value of Avogadro's constant do **these figures** give?

A 6.02×10^{23} **B** 6.06×10^{23} **C** 3.03×10^{23} **D** 1.21×10^{24}

29 When a few drops of $NH_3(aq)$ are added to $Cu(NO_3)_2(aq)$, a pale blue precipitate is formed. This precipitate dissolves when an excess of $NH_3(aq)$ is added, forming a deep blue solution.

Which process does not occur in this sequence of reactions?

A ligand exchange
B acid-base reaction
C precipitation
D redox reaction

30 Which set of data correctly illustrates titanium as a typical transition metal element and calcium as an s-block element?

	property	titanium	calcium
1	melting point / ^oC	1668	842
2	density/ g cm^{-3}	4.5	1.55

A both 1 and 2
B 1 only
C 2 only
D neither 1 nor 2