

NANYANG JUNIOR COLLEGE
JC 2 Preliminary Examination
Higher 2

CHEMISTRY

9729/01

Paper 1 Multiple Choice

20 Sep 2022

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, CT and NRIC / FIN on the Answer Sheet in the spaces provided.

There are **thirty** 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 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.

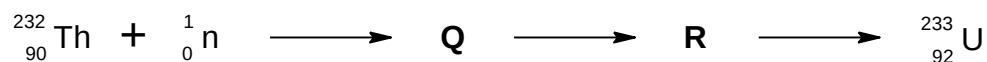
Any rough working should be done in this booklet.

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

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

Outside the city of Wuwei in China, there is an experimental nuclear reactor that has the potential to generate much smaller amounts of radioactive wastes compared to conventional reactors.

In this reactor, isotopes of thorium-232 are irradiated with neutrons to produce isotope **Q**, which then decompose to form isotope **R**, and finally to uranium-233 in a three-step radioactive decay reaction shown below.



Which row describes:

- the identity of the element of isotope **Q**,
- the neutron number of isotope **R**?

	Q	neutron number of R
A	protactinium	142
B	protactinium	141
C	thorium	142
D	thorium	141

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

Which element has the highest 3rd ionisation energy?

- A** Cd **B** Rb **C** Sr **D** Xe

- 3** Gallium, atomic number 31, is a silvery blue lustrous solid. It has a low melting point of 29.8 °C, becoming silvery white in the liquid state. Analysis of the crystal structure of gallium shows the existence of only covalent Ga₂ dimers.

Unlike its melting point, gallium has a high boiling point of 2400 °C, similar to other Group 13 elements such as aluminium and indium. Ga₂ dimers are not present in liquid gallium.

Which statements explain the observed melting and boiling points of Gallium?

- 1 In the liquid state, gallium exist as cations surrounded by a sea of delocalised valence electrons.
- 2 In the solid state, there are weak instantaneous dipole-induced dipole interactions between Ga₂ dimers.
- 3 In the solid state, there are strong covalent bonds between Ga atoms.

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

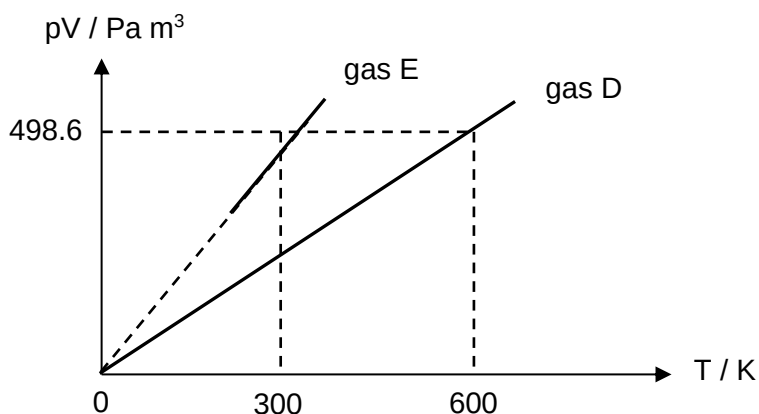
- 4** At sea level, an inflated bicycle tyre has an internal pressure of 6.8 bar and a temperature of 30 °C. The instructions on the tyre state 'Safety note: internal pressure must not exceed external pressure by 6 bar.' The atmospheric pressure is 1 bar. The tyre will burst if the difference between the internal pressure and the external pressure becomes too great.

The tyre is placed in the luggage hold of an airliner. The conditions in the luggage hold of this airliner are a temperature of 2 °C and a pressure of 0.47 bar.

Assuming the maximum volume of the tyre does not change, which statement explains what will happen to the tyre in the luggage hold?

- A** The tyre will burst as the temperature in the luggage hold will cause the tyre to exceed its maximum allowed temperature.
- B** The tyre will deflate as its internal pressure will be lower than the air pressure in the luggage hold.
- C** The tyre will burst as its internal pressure exceeds the air pressure by the maximum allowed.
- D** The tyre will neither deflate nor burst as the difference between its internal pressure and the air pressure is within the maximum allowed.

- 5 An experiment was carried out to determine how the pressure and volume of an ideal gas D vary with different temperature. The graph below was obtained.



Which is most likely to be gas E?

- A 34.02 g of silicon chloride
 B 12.82 g of sulfur dioxide
 C 3.100 g of phosphorus
 D 0.2000 g of hydrogen
- 6 Which standard enthalpy change is represented by the correct equation?

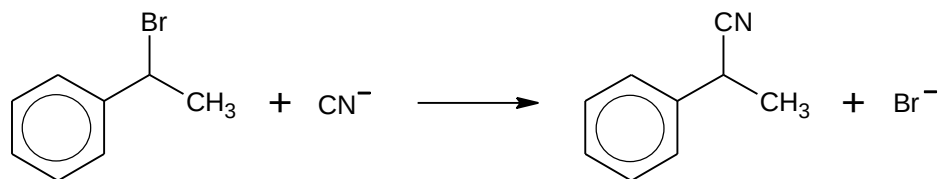
A	$\text{C(s)} + \text{O}_2\text{(g)} \rightarrow \text{CO}_2\text{(g)}$	$\Delta H_f^\ominus(\text{CO}_2)$
B	$\text{H}_2\text{SO}_4\text{(aq)} + 2\text{NaOH(aq)} \rightarrow \text{Na}_2\text{SO}_4\text{(aq)} + 2\text{H}_2\text{O(l)}$	$\Delta H_{\text{neut}}^\ominus$
C	$\text{K}^+\text{(g)} \rightarrow \text{K}^+\text{(aq)}$	$\Delta H_{\text{sol}}^\ominus(\text{K}^+)$
D	$\text{S(g)} \rightarrow \text{S}^{2-}\text{(g)} + 2\text{e}^-$	$\Delta H_{2^{\text{nd}}\text{EA}}^\ominus(\text{S})$

- 7 Which of the following process have different signs for $\Delta G^\ominus$ and $\Delta S^\ominus$?

- $\text{SO}_3\text{(l)} + \text{H}_2\text{O(l)} \rightarrow \text{H}_2\text{SO}_4\text{(aq)}$
- $\text{Cl}_2\text{(g)} + 2\text{I}^-\text{(aq)} \rightarrow \text{I}_2\text{(aq)} + 2\text{Cl}^-\text{(aq)}$
- $\text{MgCO}_3\text{(s)} \rightarrow \text{MgO(s)} + \text{CO}_2\text{(g)}$

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

- 8 The reaction of (1-bromoethyl)benzene with sodium cyanide, NaCN, is investigated in a series of experiments.

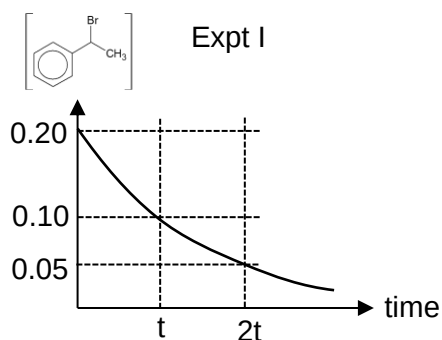


Experiment	$\left[\text{C}_6\text{H}_5\text{CH}(\text{Br})\text{CH}_3 \right] / \text{mol dm}^{-3}$	$[\text{CN}^-] / \text{mol dm}^{-3}$
I	0.20	2.00
II	2.00	0.20
III	2.00	2.00

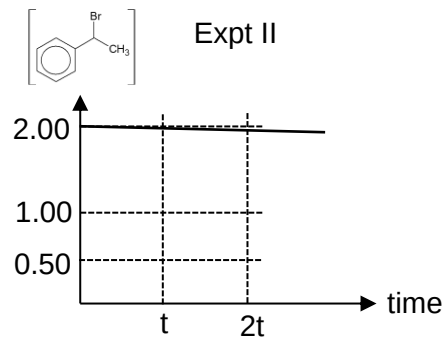
It was known that the reaction is first order with respect to (1-bromoethyl)benzene.

Which graph shows a correct experimental result and proves the reaction is zero order with respect to sodium cyanide?

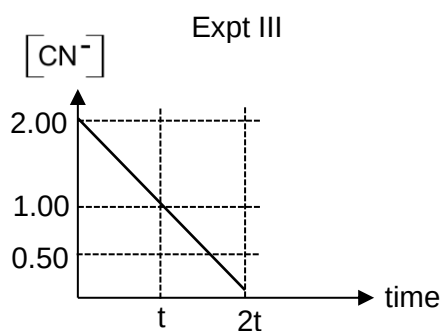
A



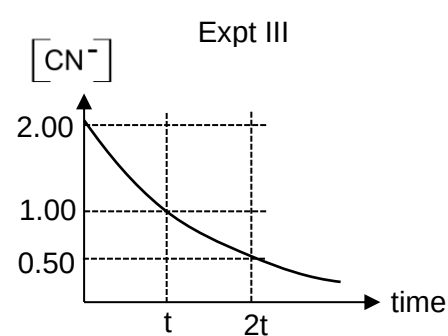
B



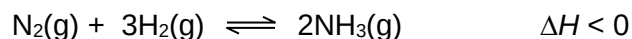
C



D



- 9 In the Haber process, nitrogen and hydrogen is passed over a hot catalyst to produce ammonia.



Which row correctly describes the operating condition and the possible reason?

[POE – position of equilibrium]

	operating condition	reason
A	500 atm	high pressure to shift POE to the right
B	500 °C	high temperature to increase rate of reaction
C	60 atm	low pressure to shift POE to the right
D	60 °C	low temperature to shift POE to the right

- 10 The ionic product of water, K_w , is affected by temperature. The table gives the pK_w of pure water at different temperatures.

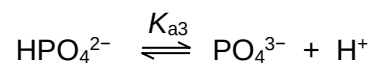
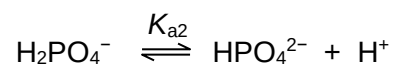
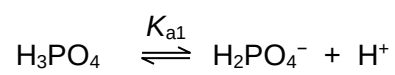
temperature / °C	pK_w
10	14.5
40	13.5

Solutions of acids and alkalis are prepared by dissolving HCl or NaOH in pure water at 10 °C and at 40 °C.

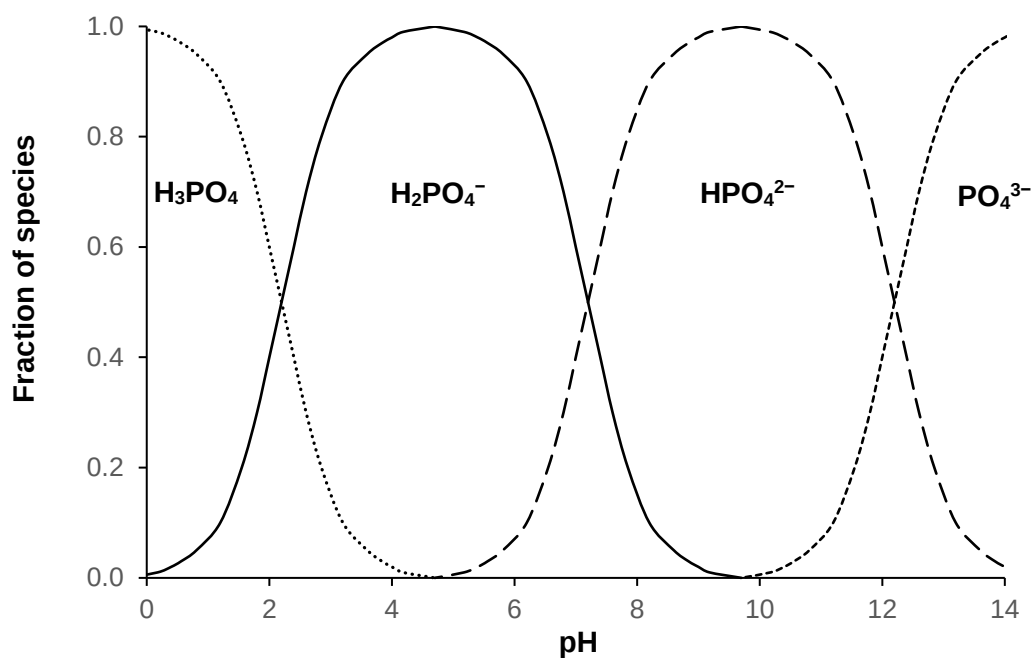
Which solution has the highest ionic concentration?

- A** HCl(aq) at pH 1 at 40 °C.
B HCl(aq) at pH 1 at 10 °C
C NaOH(aq) at pH 13 at 40 °C.
D NaOH(aq) at pH 13 at 10 °C.

- 11 Phosphoric acid is a tribasic acid.



The graph shows the fraction of each species at different pH.



What is the numerical value of K_{a2} ?

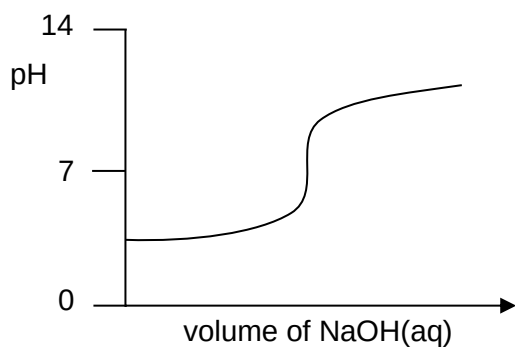
- A** 6.3×10^{-3} **B** 2.0×10^{-5} **C** 6.3×10^{-8} **D** 2.0×10^{-10}

- 12 Pyruvic acid is a weak acid that is an important intermediate in many biochemical processes.

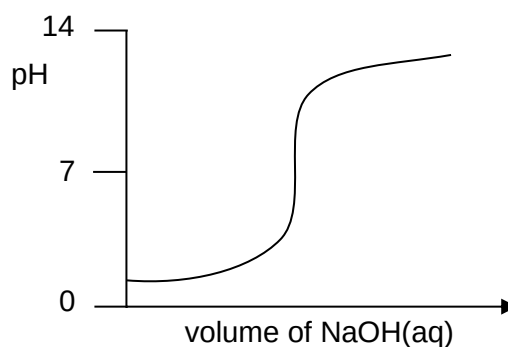


Which graph best represents the change in pH that occurs when a sample of pyruvic acid is titrated against NaOH(aq)?

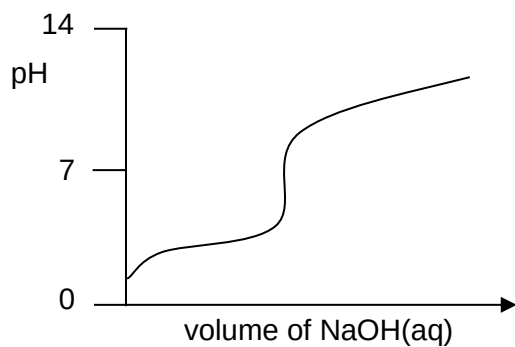
A



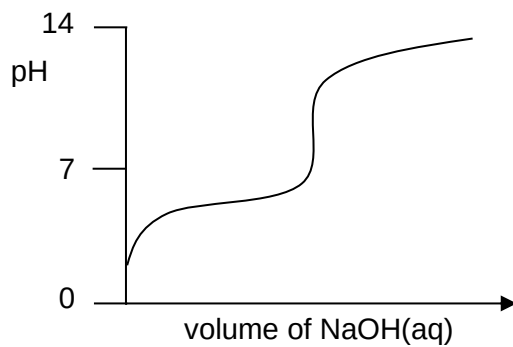
B



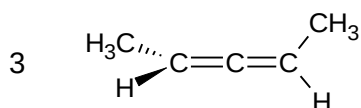
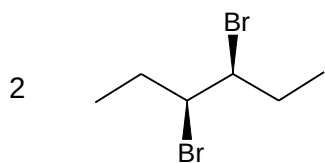
C



D



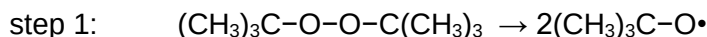
13 Which of the following compound will rotate plane-polarised light?



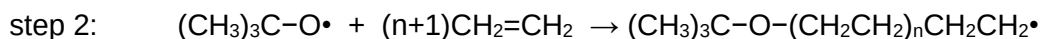
A 1, 2 and 3 **B** 1 and 2 only **C** 2 and 3 only **D** 1 only

- 14** Low density polyethene, LDPE, is used in the manufacture of plastic bags due to it being lightweight and flexible.

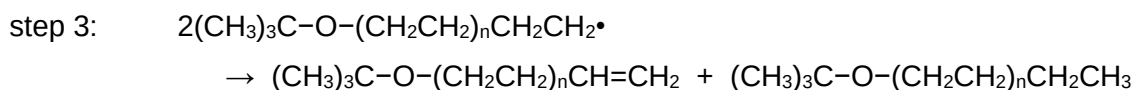
LDPE is produced in an addition reaction. To start the reaction, reactive molecules such as *tert*-butylperoxide, $(\text{CH}_3)_3\text{C}-\text{O}-\text{O}-\text{C}(\text{CH}_3)_3$, is added to the ethene substrate.



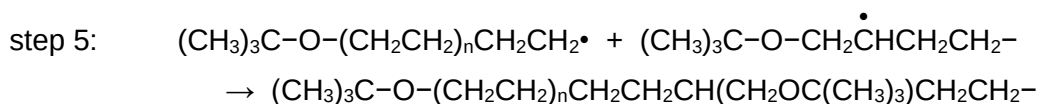
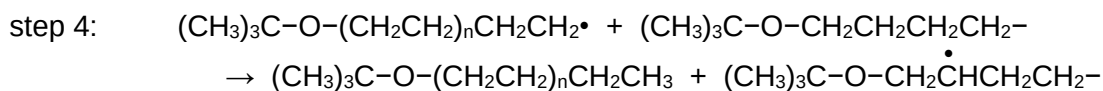
The reactive species, $(\text{CH}_3)_3\text{C}-\text{O}\cdot$, combined with molecules of ethene resulting in a growing polymer chain.



The lengthening chain can be stopped by a disproportionation reaction.



Sometimes, chain transfer reactions take place to form branching in the polymer.

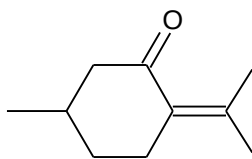


Such branching result in the formation of the low density polymers.

Which statement is **not** correct?

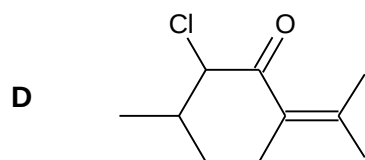
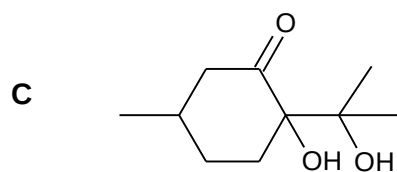
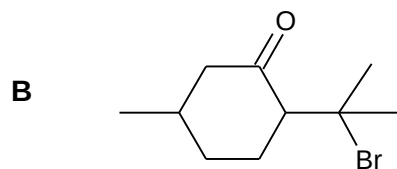
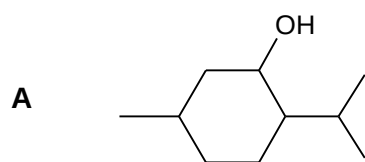
- A** The formation of LDPE involves free radical addition mechanism.
- B** The reaction in step 1 involves heterolytic fission.
- C** The reaction in step 2 is propagation.
- D** The reaction in step 5 is termination.

- 15 Pulegone is an oily liquid with a pleasant odour similar to peppermint.

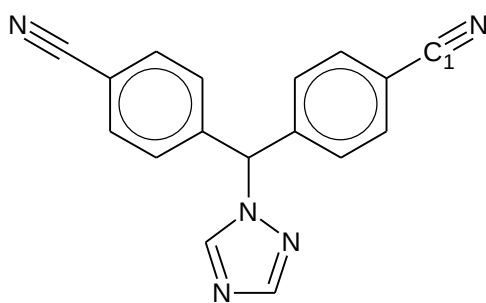


pulegone

Which product is formed from an electrophilic addition reaction with pulegone?



- 16 Letrozole is a drug used to treat some forms of breast cancer.



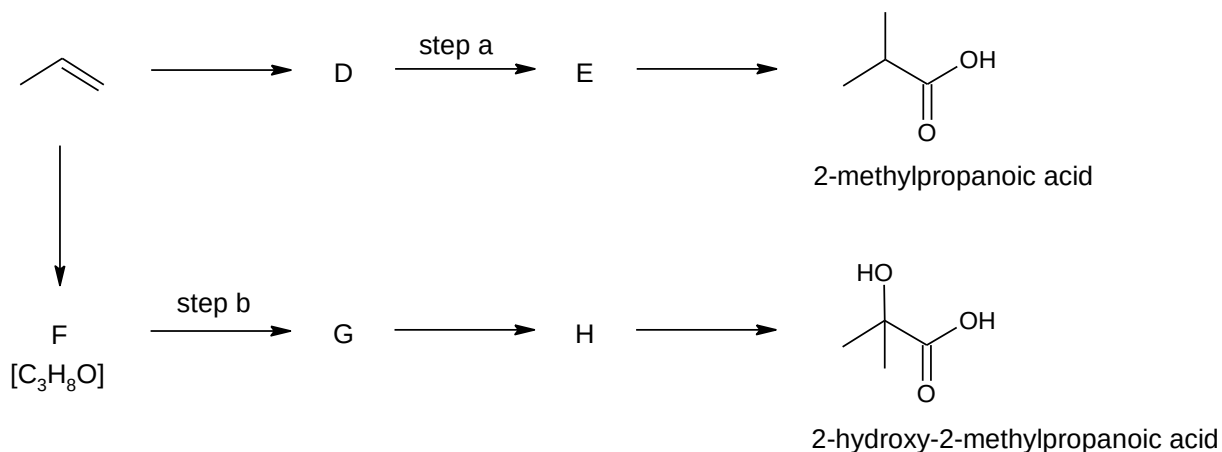
letrozole

Which statements about letrozole are correct?

- 1 There are 14 carbon atoms with bond order 2.
- 2 Letrozole is a planar molecule.
- 3 The π electrons on C_1 is delocalised into the aromatic ring.

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

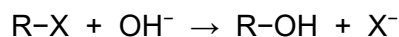
- 17 Propene is the starting reagent for two synthesis pathways as shown below.



Which row shows the correct reagent and condition for step a and step b?

	step a	step b
A	NaCN, ethanol, heat	HCl(aq), K ₂ Cr ₂ O ₇ (aq), heat
B	PBr ₃	SOCl ₂
C	KCN, ethanol, heat	HCN(aq), trace NaOH(aq), 10 °C
D	CH ₃ Cl, ethanol, heat in sealed tube	PCl ₅

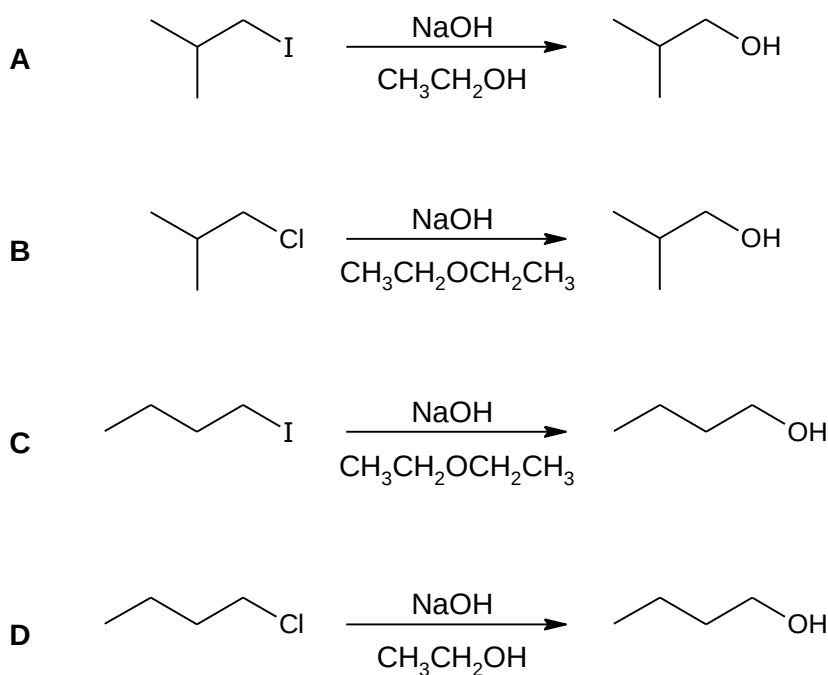
18 Aliphatic halogenoalkanes can undergo bimolecular nucleophilic substitution reaction.



Some of the factors that affect the reactivity of bimolecular nucleophilic substitution reactions are explained below.

Factor affecting reactivity	Explanation
Steric effect	Bulky groups in reactant molecules blocked the approach of incoming nucleophiles, decreasing reactivity of these reactants.
Solvent effect	Protic solvents containing -OH or -NH groups form hydrogen bonds with ionic reactants, such as OH^- , dispersing the negative charge to a larger extent, decreasing the reactivity of these reactants.

Which hydrolysis reaction should have the fastest rate?



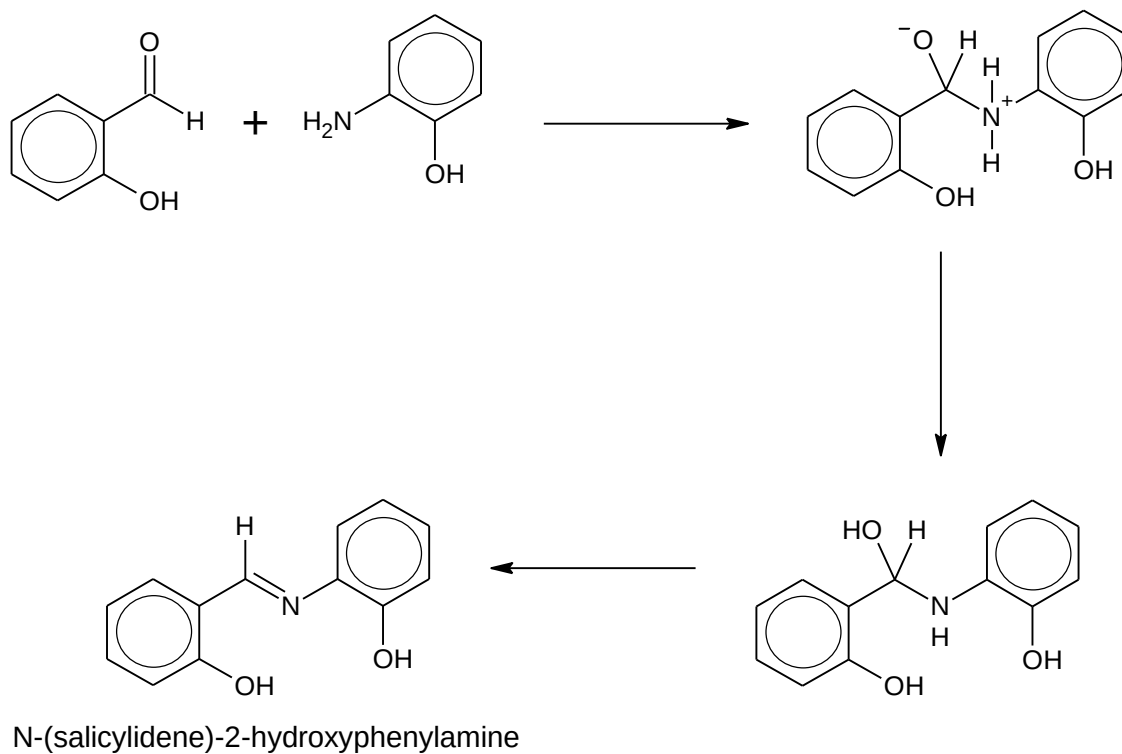
- 19** Four organic compounds are tested with common reagents found in the laboratory. Only one of the four is known to have an alkene functional group.

In which compound must the alkene be present?

A	$C_6H_{14}O$	• hot acidified $K_2Cr_2O_7(aq)$ turns green • effervescence with sodium metal
B	$C_6H_{12}O$	• orange precipitate with 2,4-dinitrophenylhydrazine • decolourise hot acidified $KMnO_4(aq)$
C	$C_6H_{10}O$	• silver mirror with warm alkaline $Ag(NH_3)_2^+(aq)$ • decolourise hot acidified $KMnO_4(aq)$
D	C_6H_6O	• decolourise orange $Br_2(aq)$ • dissolves in $NaOH(aq)$

- 20 Schiff bases are organic compounds with an imine functional group, C=N. Recent research have shown Schiff bases to have anti-biotic properties.

The following pathway shows the formation of N-(salicylidene)-2-hydroxyphenylamine, a Schiff base with anti-bacterial properties.



Which type of reaction is **not** present?

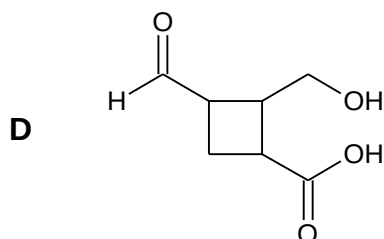
- A Acid-base
- B Condensation
- C Elimination
- D Nucleophilic substitution

- 21** Compound S reacts with concentrated H_2SO_4 to form a compound with molecular formula $\text{C}_7\text{H}_{10}\text{O}_3$.

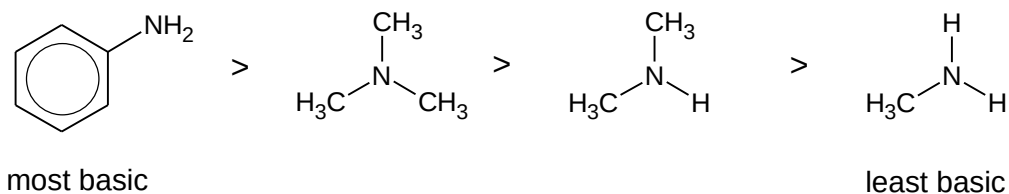
Compound S also reacts with a warm solution of sodium hydroxide and copper(II)-complex to form a red precipitate and a salt with formula $\text{Na}_2\text{C}_7\text{H}_{10}\text{O}_5$.

What could be the identity of S?

- A** $\text{HO}_2\text{CCH}(\text{OH})\text{C}(\text{CH}_3)_2\text{CH}_2\text{CHO}$
B $\text{HO}_2\text{CCH}_2\text{C}(\text{CH}_3)_2\text{CH}(\text{OH})\text{CHO}$
C $\text{HCOCH}_2\text{CH}_2\text{CH}(\text{OH})\text{CH}_2\text{CH}_2\text{CHO}$



- 22** Amines react with acids in the gas phase to form salts. The relative basic strength follows the order given.

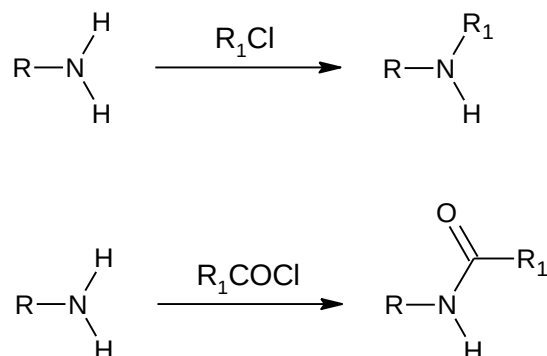


Which statements can be used to explain the order of basicity?

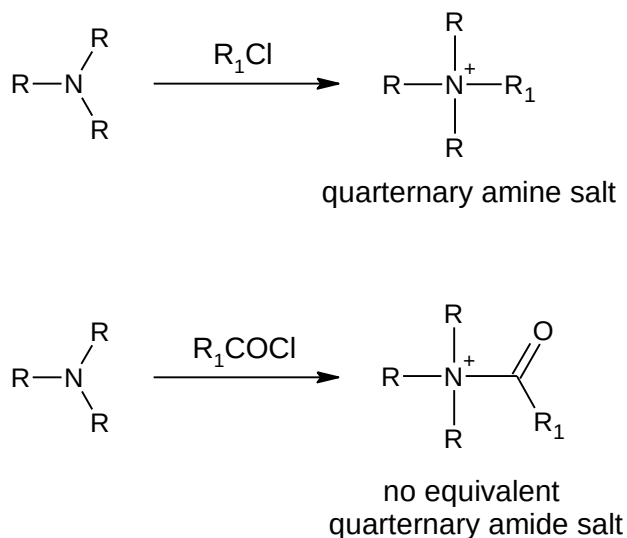
- 1 Phenyl groups are stronger electron-donating groups than alkyl groups.
- 2 Alkyl groups have steric effect.
- 3 Negative charge on nitrogen atom is dispersed into the benzene ring.

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

- 23 A primary amine can undergo alkylation to form a secondary amine or it can undergo acylation to form a secondary amide.



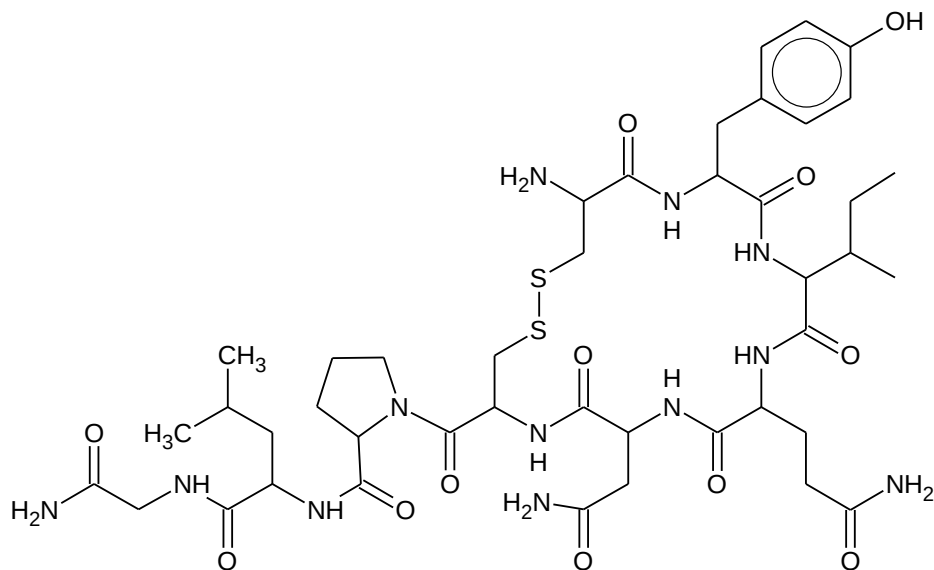
However, a tertiary amine can only undergo alkylation to form a quaternary amine salt. It does not undergo acylation to form the equivalent amide.



Which statement explains why a tertiary amine does **not** undergo acylation?

- A The acyl group is an electron-withdrawing group unlike an alkyl group.
- B An acyl chloride is a weaker electrophile than an alkyl chloride.
- C The tertiary amine is a stronger nucleophile than a primary amine.
- D There is no N-H bond on a tertiary amine unlike in a primary amine.

- 24** Oxytocin is a small protein that is involved in childbirth, breastfeeding and maternal behavior. The structure of oxytocin is given below. Two of the amino acids are cysteine, with $-\text{CH}_2\text{SH}$ side chain. These side chains are joined by a $-\text{S}-\text{S}-$ bond in oxytocin.



Which two statements about oxytocin are correct?

- 1 Oxytocin is a nonapeptide.
- 2 There are eight chiral carbons in oxytocin.
- 3 In addition to cysteine, three other amino acids have side-chains that can react with hot NaOH(aq) .
- 4 The N-terminal of oxytocin is glycine whose R group is $-\text{H}$.

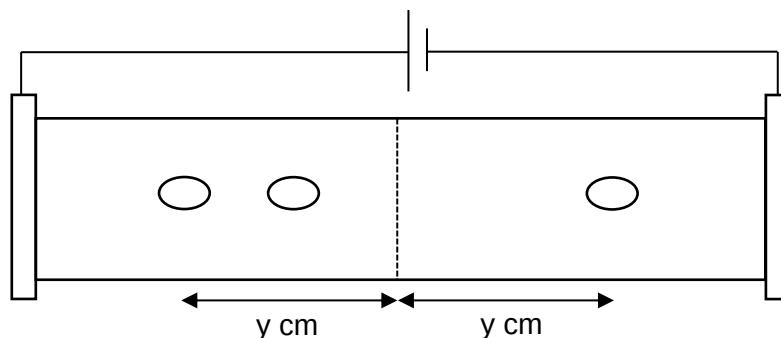
A 1 and 3 **B** 2 and 3 **C** 2 and 4 **D** 1 and 4

- 25 Electrophoresis is used in the separation and identification of amino acids from peptides hydrolysis.

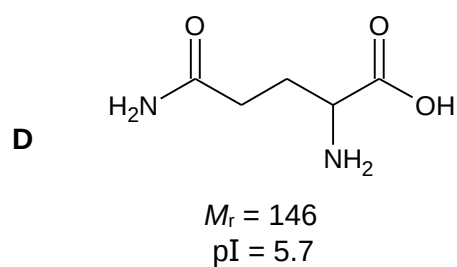
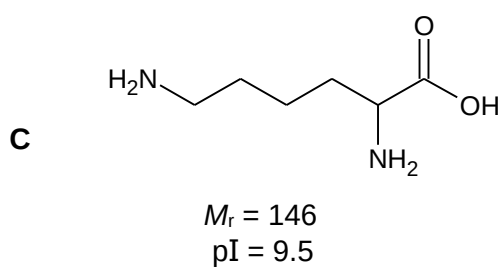
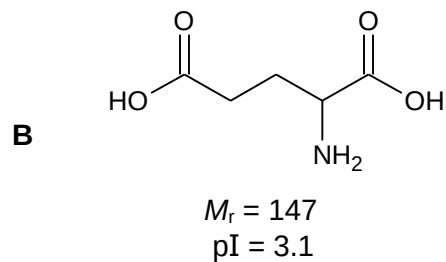
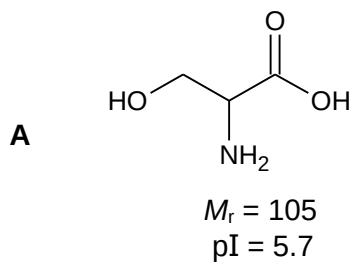
The distance travelled by each amino acid is given by the relationship:

$$\text{distance} \propto \frac{\text{charge}}{\text{molecular mass}}$$

A mixture known to contain three amino acids was separated in a solution buffered at pH 6. The result of the electrophoresis is shown.



Which amino acid is **not** present?



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

An excess of aluminium powder is added into an acidified solution containing 1 mol dm^{-3} uranium(VI) ions.

Electrode reaction	$E^\ominus / \text{V}$
$\text{UO}_2^{2+} + \text{e}^- \rightleftharpoons \text{UO}_2^+$	+0.16
$\text{UO}_2^+ + 4\text{H}^+ + \text{e}^- \rightleftharpoons \text{U}^{4+} + 2\text{H}_2\text{O}$	+0.27
$\text{U}^{4+} + \text{e}^- \rightleftharpoons \text{U}^{3+}$	-0.52
$\text{U}^{3+} + 3\text{e}^- \rightleftharpoons \text{U}$	-1.66

Assuming all feasible reactions occur quickly, how many moles of aluminium is required to react completely with one mole of uranium(VI) ions?

- A** 2.00 **B** 1.67 **C** 1.00 **D** 0.67

27 Use of the Data Booklet is relevant to this question.

The standard electrode potential, $E^\ominus$, of a half-cell is the maximum potential difference between the electrode of the half-cell and the hydrogen electrode, measured under standard conditions.

Which of the following is one of the conditions necessary to measure the $E^\ominus(\text{MnO}_2/\text{Mn}^{2+})$ half-cell?

- 1 298 K
- 2 100 kPa atmospheric pressure
- 3 $4 \text{ mol dm}^{-3} \text{H}^+(\text{aq})$

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

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

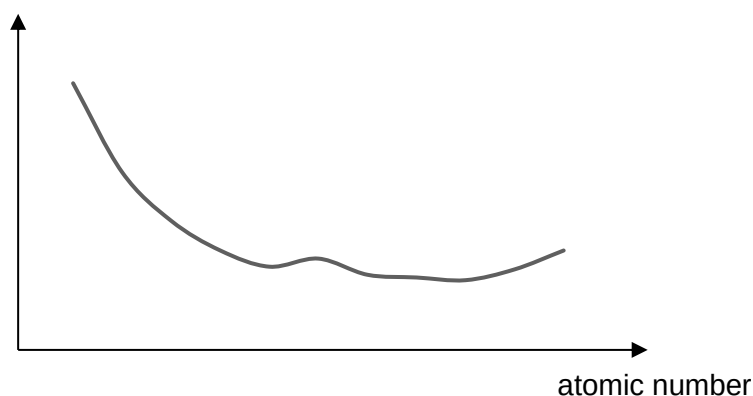
An electrolysis cell is set up with an anode made of an alloy of Cu and Ni and a cathode made of pure Cu. The electrolyte is 1.0 dm^3 of a solution which contains 1.000 mol of NiSO_4 and 1.000 mol of CuSO_4 .

A current of 2.4 A is passed through the cell. After 4.2 hours , the amount of NiSO_4 in the electrolyte has increased to 1.047 mol .

What is the decrease in mass of the anode?

- A** 11.0 **B** 11.7 g **C** 11.9 **D** 23.7

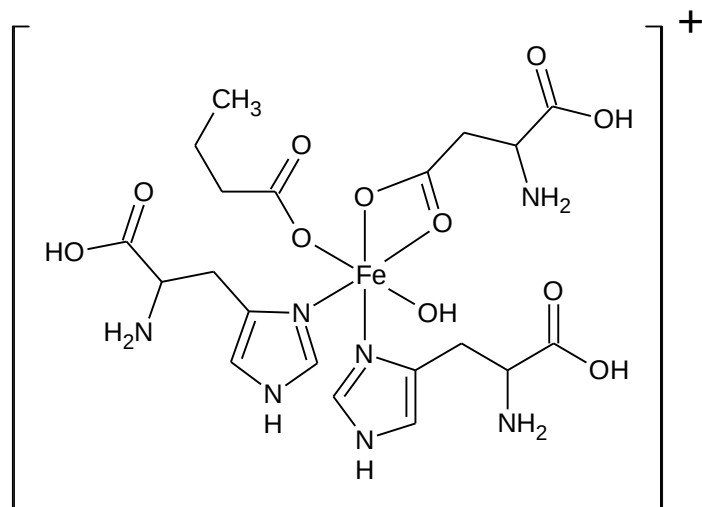
- 29 The graph below shows a physical property of some consecutive Period 4 elements from K to Zn.



What is the y-axis?

- A** Atomic radius
B Electrical conductivity
C First ionisation energy
D Melting point

- 30** Complexes containing Fe are involved in many biochemical reactions. One such complex involved in cellular respiration is shown below.



Two students, J and K, sitting for the A-Levels H2Chemistry examinations in November saw this structure and each made a comment.

- student J The electronic configuration of iron in this complex is definitely $[\text{Ar}] 3d^4$.
- student K There are definitely five ligands in this complex.

Which students are correct?

- A** neither J nor K
- B** J only
- C** K only
- D** both J and K