

RAFFLES INSTITUTION
2020 YEAR 6 PRELIMINARY EXAMINATION

Higher 2



CHEMISTRY

Paper 1 Multiple Choice

9729/01

24 September 2020

1 hour

Additional Materials: Multiple Choice Answer Sheet
 Data Booklet

READ THESE INSTRUCTIONS FIRST

Do not open this question booklet until you are told to do so.

Write in soft pencil.

Do not use staples, paper clips, glue or correction fluid.

Write your name, class and index number in the spaces provided on the Answer Sheet.

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 the question booklet.

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

This document consists of **15** printed pages.

- 1** A sample containing four isotopes of xenon has a relative atomic mass of 131.31. The percentage abundances of the isotopes in the sample are shown below.

isotope	^mXe	^{131}Xe	^{132}Xe	^{134}Xe
percentage abundance	28.0	25.0	27.0	20.0

What is the value of m ?

- | | | | |
|----------|-----|----------|-----|
| A | 126 | C | 129 |
| B | 128 | D | 130 |

- 2** 5 moles of halide ion, X^- , can react with 1 mole of halate ion, XO_n^- , to form a single halogen-containing product.

Which row shows the value of n and the identity of the halogen-containing product?

	n	halogen-containing product
A	1	X_2
B	2	XO^-
C	3	X_2
D	4	XO^-

- 3 At 298 K, two vessels are connected by a stopcock. The 5 dm³ vessel is filled with argon at a pressure of 150 kPa and the 10 dm³ vessel is filled with xenon at 350 kPa. The stopcock is then opened to allow the gases to mix at 298 K, resulting in a total pressure of **P** kPa.

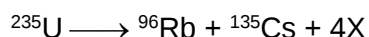
Subsequently, the two vessels are heated to a temperature of T K and the total pressure at T K is 600 kPa.

Assuming that the gases do not react at all temperatures, what are the values of **P** and **T**?

	P	T
A	217	437
B	217	824
C	283	570
D	283	632

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

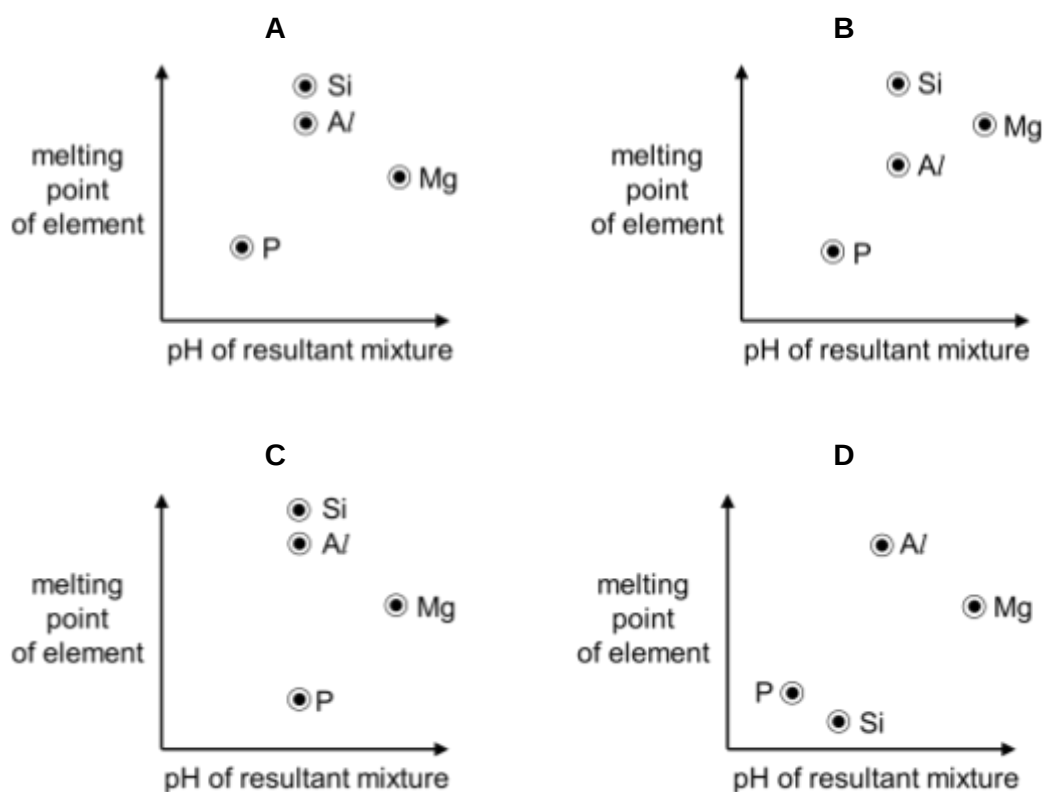
In a nuclear reaction, uranium-235 decays as shown below.



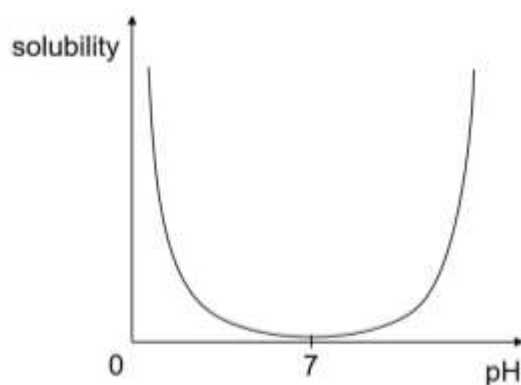
What is X?

- A neutron
B proton
C electron
D hydrogen-1
- 5 Oxides of elements Mg, Al, Si and P are separately added to water and the pH of their resultant mixtures are measured.

Which graph shows the correct trends when the melting points of these elements are plotted against the pH of the resultant mixtures?

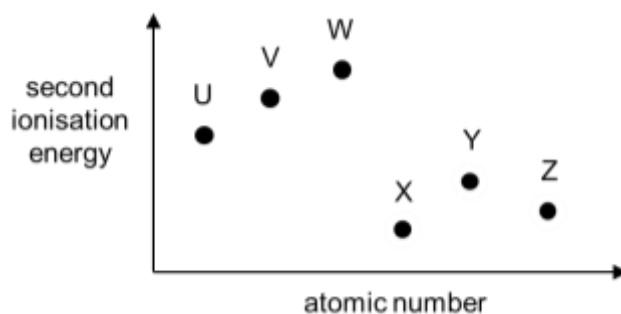


- 6 The graph below shows the solubility of a compound at different pH values.



What could be the compound?

- A** aluminium chloride **C** magnesium chloride
B aluminium hydroxide **D** magnesium hydroxide
- 7 The graph shows the second ionisation energies of six consecutive elements with atomic numbers less than 20.



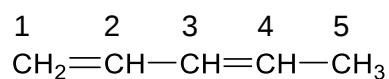
Which statements are correct?

- 1 V could be helium.
 - 2 W reacts more vigorously than X with water.
 - 3 Y has a higher electrical conductivity than Z.
- A** 1, 2 and 3 **C** 1 and 3 only
B 1 and 2 only **D** 2 and 3 only

8 Which of the following **increases** down Group 2?

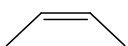
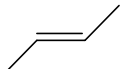
- A reducing power
- B electronegativity
- C magnitude of $\Delta H_{\text{hydration}}$ of the ions
- D magnitude of lattice energy of the chlorides

9 The structure of penta-1,3-diene is shown below.



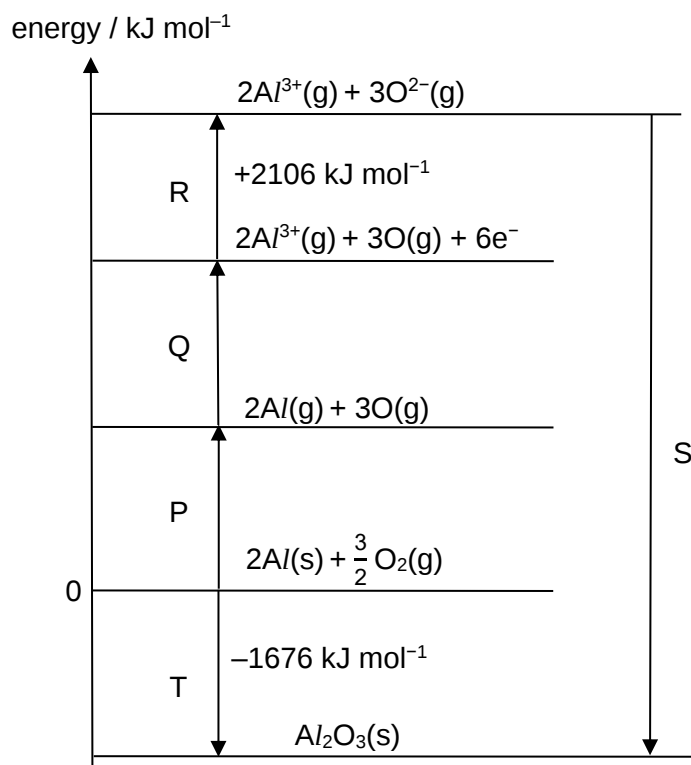
Which statement about penta-1,3-diene is correct?

- A Both C1 and C3 are sp hybridised.
 - B The C2–C3 bond is shorter than the C4–C5 bond.
 - C There are four σ bonds in a molecule of penta-1,3-diene.
 - D The π electrons are able to move freely between C1 and C5.
- 10 In which of the following pairs does the first compound have a higher melting point than the second compound?

	first compound	second compound
A	SiCl_4	SiO_2
B	NaCl	Na_2O
C	NaCl	AlCl_3
D		

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

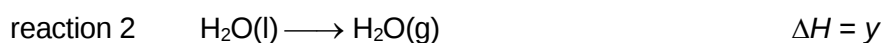
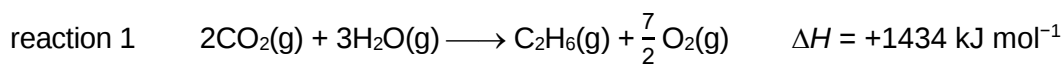
A Born Haber cycle involving aluminium oxide is shown below.



Which statement is correct?

- A The enthalpy change for step Q is $+5137 \text{ kJ mol}^{-1}$.
- B The sum of the first and second electron affinity of oxygen is $+702 \text{ kJ mol}^{-1}$.
- C The enthalpy change for step P is the sum of $2\Delta H^\ominus_{\text{atom}}(\text{Al})$ and $\frac{3}{2}\Delta H^\ominus_{\text{atom}}(\text{O}_2)$.
- D Lattice energy of aluminium oxide is the sum of the enthalpy changes in steps P, Q, R and T.

12 Consider the following reactions.



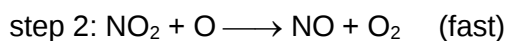
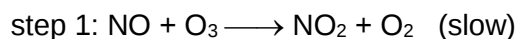
The standard enthalpy change of combustion of ethane is $-1542 \text{ kJ mol}^{-1}$.

Which statements are correct?

- 1 y is $+36 \text{ kJ mol}^{-1}$.
- 2 At 373 K , ΔS for reaction 2 is $\frac{y}{373} \text{ kJ mol}^{-1} \text{ K}^{-1}$.
- 3 Reaction 1 is spontaneous only at high temperatures.

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

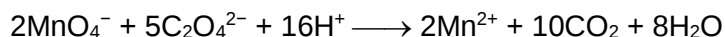
13 Aircraft in the stratosphere releases nitrogen monoxide, NO, which catalyses ozone breakdown by the mechanism shown below.



Which statement regarding this catalysis mechanism is **not** correct?

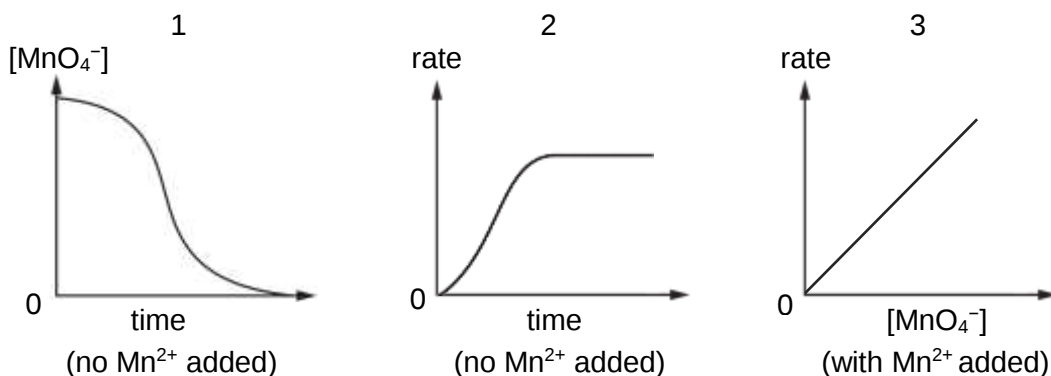
- A** NO_2 is a free radical.
- B** O is a reaction intermediate.
- C** The reaction is overall second order.
- D** NO acts as a homogeneous catalyst.

- 14** Manganate(VII) ions, MnO_4^- , undergo a redox reaction in acidic solution with ethanedioate ions, $\text{C}_2\text{O}_4^{2-}$.



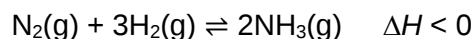
The reaction is very slow at room temperature and can be catalysed by Mn^{2+} ions. Further studies show that in the presence of the Mn^{2+} catalyst, the reaction follows a first-order kinetics with respect to the MnO_4^- ions.

Which graphs are correct?



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

- 15** Ammonia is manufactured industrially by the Haber Process.

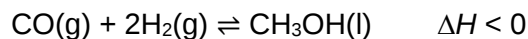


The rate constants of the forward and backward reactions are given as k_1 and k_{-1} respectively.

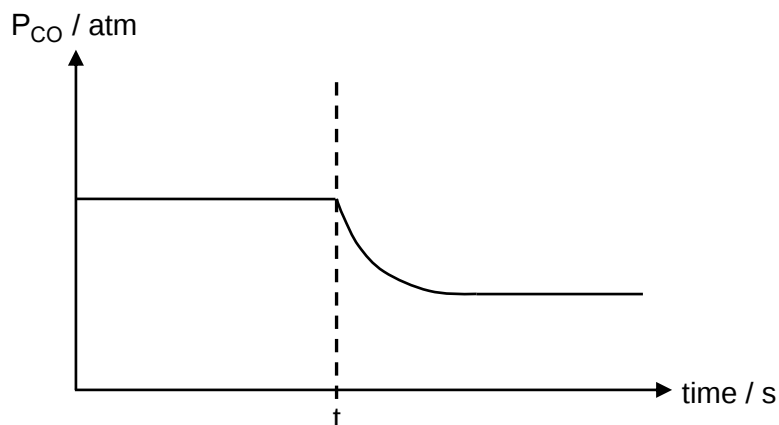
What happens to k_1 , k_{-1} and the equilibrium position when temperature is increased?

	k_1	k_{-1}	equilibrium position
A	increases	increases	shifts right
B	increases	decreases	shifts right
C	increases	increases	shifts left
D	decreases	increases	shifts left

- 16** A sealed vessel of fixed volume contains a mixture of CO(g) , $\text{H}_2\text{(g)}$ and $\text{CH}_3\text{OH(l)}$ at equilibrium.



At time t , the reaction mixture is subjected to a change. The graph below shows the partial pressure of CO against time.



Which changes, when carried out separately, could have given the graph above?

- 1 addition of $\text{H}_2\text{(g)}$
- 2 removal of some $\text{CH}_3\text{OH(l)}$
- 3 decrease in temperature

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

- 17** When aqueous NH_3 is added to a solution containing Mg^{2+} , a precipitate of Mg(OH)_2 is formed. Upon addition of solid NH_4Cl , the precipitate of Mg(OH)_2 dissolves.

Which statement explains why the precipitate dissolves on addition of solid NH_4Cl ?

- A** A soluble complex is formed.
- B** Solubility product of Mg(OH)_2 is increased.
- C** Mg^{2+} reacts with Cl^- which reduces $[\text{Mg}^{2+}]$.
- D** NH_4^+ reacts with OH^- which reduces $[\text{OH}^-]$.

- 18** Pyruvic acid, $\text{CH}_3\text{COCO}_2\text{H}$, is a weak monobasic acid that is an important intermediate in many biochemical processes.

10.0 cm³ of 0.10 mol dm⁻³ aqueous NaOH was placed in a conical flask and titrated against 0.10 mol dm⁻³ pyruvic acid in a burette.

Which statements are correct?

- 1 $\text{CH}_3\text{COCO}_2^-$ is a Brønsted-Lowry base.
- 2 Methyl orange is a suitable indicator for the titration.
- 3 A buffer with maximum buffering capacity was produced when 5 cm³ of pyruvic acid was added.

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

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

A current of 3 A is passed through aqueous copper(II) sulfate using a platinum cathode and a 0.20 g copper anode. What is the estimated time taken for the copper anode to reach half its original mass?

- | | |
|--------------------|-------------------|
| A 0.844 min | C 50.7 min |
| B 1.69 min | D 101 min |

- 20** One of the key features in the electrochemical cell is the salt bridge.

Which statements about the salt bridge is correct?

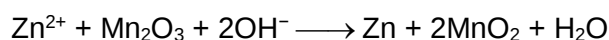
- 1 The salt bridge ensures charge neutrality in each half-cell.
- 2 Electrons move through the salt bridge from one half-cell to the other.
- 3 The salt bridge must contain ions that are the same as the electrolyte in each half-cell.

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

$$2\text{MnO}_2 + \text{H}_2\text{O} + 2\text{e}^- \rightleftharpoons \text{Mn}_2\text{O}_3 + 2\text{OH}^- \quad E^\ominus = x$$


1 x is less negative than -0.76 V.

2 The equation for the charging process is

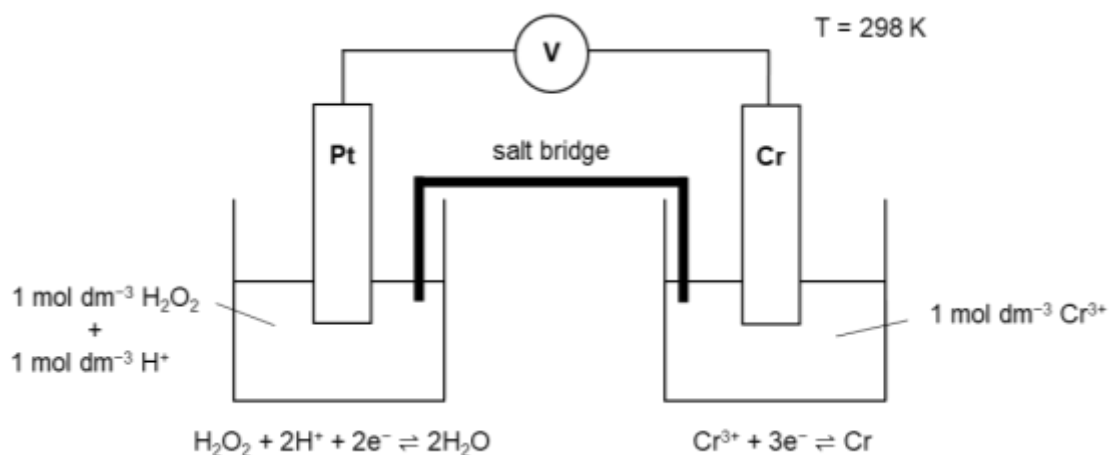


3 During the charging process, the Zn metal casing is the cathode.

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

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

The following electrochemical cell was set up.

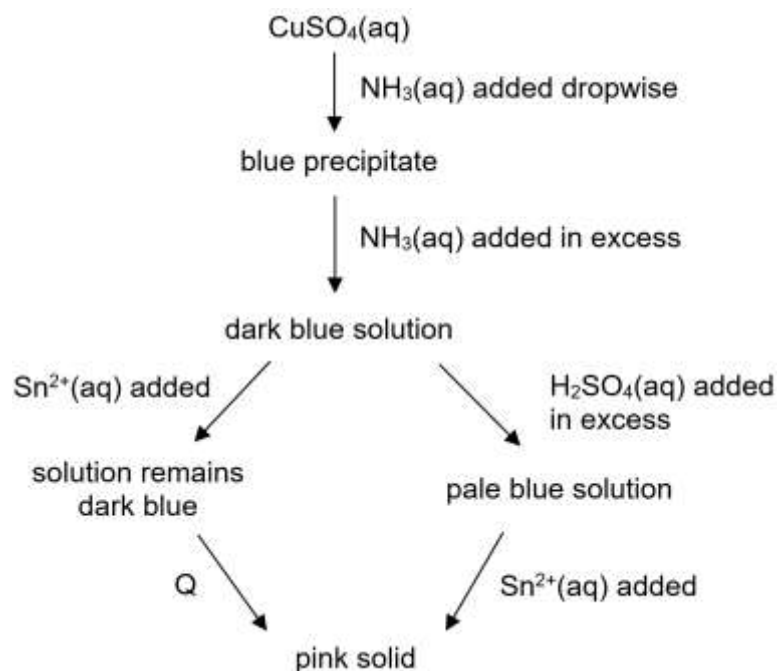


Which of the following could result in an increase in cell potential?

- A** increase $[\text{Cr}^{3+}]$ in the Cr^{3+}/Cr half-cell
B increase $[\text{H}_2\text{O}_2]$ in the $\text{H}_2\text{O}_2/\text{H}_2\text{O}$ half-cell
C addition of water to the $\text{H}_2\text{O}_2/\text{H}_2\text{O}$ half-cell
D increase the surface area of the Cr electrode

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

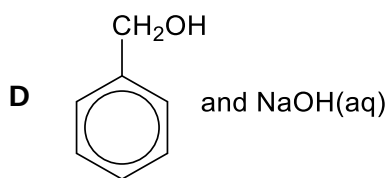
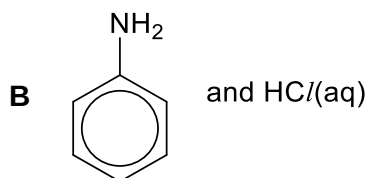
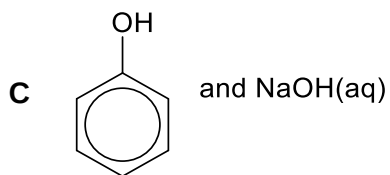
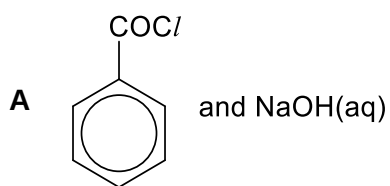
A series of tests were performed on a sample of $\text{CuSO}_4(\text{aq})$ as shown below.



Which statement is **not** correct?

- A Q could be silver metal.
- B The pink solid formed is copper metal.
- C Cu^{2+} is a stronger oxidising agent than $[\text{Cu}(\text{NH}_3)_4]^{2+}$.
- D Addition of excess $\text{H}_2\text{SO}_4(\text{aq})$ causes the reformation of $\text{Cu}^{2+}(\text{aq})$.

24 Which pair of substances, when shaken together, will give two immiscible layers?



25 Pentane was reacted with chlorine gas in the presence of ultraviolet light. How many mono-chlorinated products (including stereoisomers) are possible?

A 3

C 5

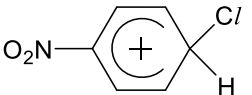
B 4

D 7

26 When heated with concentrated nitric acid in the presence of a catalyst, chlorobenzene undergoes a reaction to form 4-chloronitrobenzene.

Which statement about the above reaction is correct?

A FeCl_3 is a suitable catalyst for the reaction.

B One of the intermediates is .

C The reaction requires a lower temperature compared to benzene.

D The reaction involves the electrophilic attack of NO_2^+ on the benzene ring.

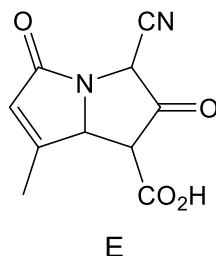
- 27 An equal amount of each of the following substances was dissolved separately in 1 dm³ of water. The pH of the resultant solutions were measured.



Which row is correct?

	lowest pH	—————→	highest pH
A	$\text{CH}_3\text{COO}^-\text{Na}^+$	$\text{CH}_3\text{CH}_2\text{O}^-\text{Na}^+$	$\text{C}_6\text{H}_5\text{O}^-\text{Na}^+$
B	$\text{C}_6\text{H}_5\text{O}^-\text{Na}^+$	$\text{CH}_3\text{CH}_2\text{O}^-\text{Na}^+$	$\text{CH}_3\text{COO}^-\text{Na}^+$
C	$\text{CH}_3\text{COO}^-\text{Na}^+$	$\text{C}_6\text{H}_5\text{O}^-\text{Na}^+$	$\text{CH}_3\text{CH}_2\text{O}^-\text{Na}^+$
D	$\text{CH}_3\text{CH}_2\text{O}^-\text{Na}^+$	$\text{C}_6\text{H}_5\text{O}^-\text{Na}^+$	$\text{CH}_3\text{COO}^-\text{Na}^+$

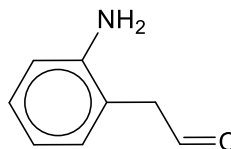
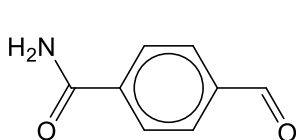
- 28 The structure of compound E is shown below.



Compound E reacts with excess LiAlH_4 in dry ether to yield compound F.

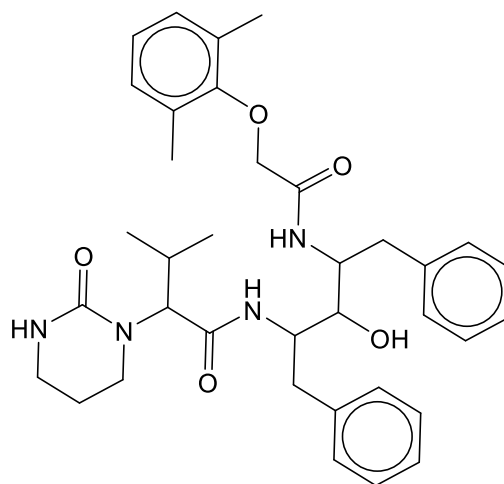
Which statement about compound F is correct?

- A One mole of F reacts with two moles of HBr .
- B One mole of F reacts with two moles of SOCl_2 .
- C One mole of F reacts with four moles of CH_3COCl .
- D One mole of F reacts with sodium metal to produce two moles of H_2 gas.
- 29 Which reagent **cannot** be used to distinguish between the following compounds?



- A Tollens' reagent
- B Fehling's solution
- C $\text{Br}_2(\text{aq})$
- D $\text{NaOH}(\text{aq})$, heat

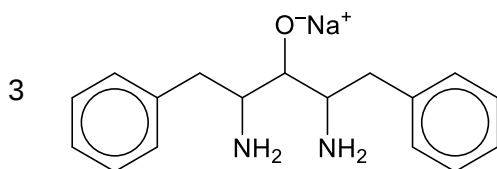
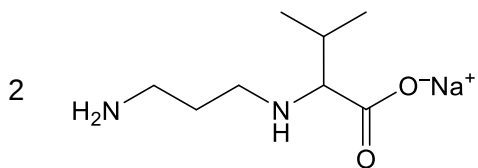
- 30 Lopinavir is used for the treatment of HIV infections. The structure of lopinavir is shown below.



lopinavir

Which compounds can be formed when lopinavir is subjected to prolonged heating with aqueous sodium hydroxide?

1 CO_2



A 1 and 3 only

B 2 and 3 only

C 1 only

D 2 only