ST ANDREW'S JUNIOR COLLEGE

JC2 Preliminary Examinations

Higher 2

CANDIDATE NAME	
CLASS	2 0 S

CHEMISTRY **9729/01**

Paper 1 Multiple Choice **16 September 2021**

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 and class 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.

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 **15** printed pages.

1 Which of the following contains the same number of particles as 16 g of oxygen atoms?

A The number of molecules in 24 dm^3 of Cl_2 under room conditions

B The number of ions in 1 dm^3 of 1 mol dm^{-3} aqueous HCl

C The number of atoms in 111.6 g of Fe

D The number of formula units of 29.25 g of NaCl

2 The first eight ionisation energies of an element **Q** (in kJ mol^{-1}) are as follows:

966, 1950, 2730, 4850, 6020, 12300, 15400, 18900

Which of the following statements about element **Q** is correct?

A It can form a basic oxide.

B It can form a chloride with the formula **Q**Cl_5.

C It has an even number of protons in its atom.

D It can form a chloride that is trigonal planar in shape.

3 A 2.0 g sample containing 0.0130 mol of organoboron compound, with the formula $C_xH_yBO_z$, was burnt in an excess of oxygen. 4.58 g of CO_2 and 1.76 g of H_2O were produced. What is the molecular formula of the organoboron compound?

A CH_2BO_2

B $C_8H_7BO_2$

C $C_8H_{15}BO_2$

D $C_9H_{15}BO$

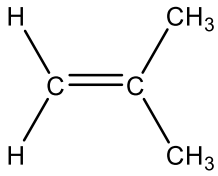
4 Beams of charged particles travelling at the same speed from different sources are subjected to an electric field in two different experiments.

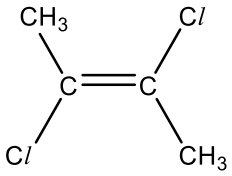
In the first experiment, protons are deflected by an angle of $+12^o$. In another experiment under identical conditions, particle **X** is deflected by an angle of -4^o.

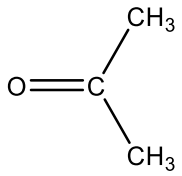
What could be the composition of particle **X**?

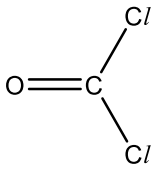
	protons	**neutrons**	**electrons**
A	1	2	1
B	3	3	5
C	4	5	1
D	4	5	5

5 Which molecule has the largest overall dipole moment?

A 

B 

C 

D 

6 Which statements about the lattice structure of the crystalline solid of diamond and ice are correct?

1 The hybridisation of the oxygen atom in ice and the carbon atom in diamond are the same.

2 The H-O-H bond angle is 105^{o} while the C-C-C bond angle is 109.5^{o}.

3 The lattice structure are held by strong covalent bonds only.

A 1, 2 and 3

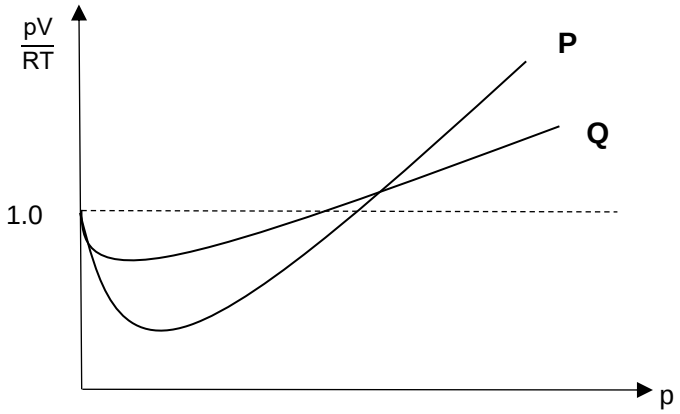
B 2 and 3 only

C 1 only

D 2 only

7 The value of $\frac{pV}{RT}$ is plotted against p for one mole of each of the two gases, **P** and **Q**, where p is the pressure, V is the volume and T is the temperature of the gas.

Which of the following pairs of gases could be **P** and **Q**?



	P	**Q**
A	N_2	O_2
B	CH_4	CH_3Cl
C	HCl	HF
D	HBr	F_2

8 The following reaction is thermodynamically feasible only at high temperature.

$$C(s) + CO_2(g) \rightarrow 2CO(g)$$

Which row correctly describes the signs of ΔH and ΔS for the reaction?

	ΔH	ΔS
A	–	–
B	–	+
C	+	–
D	+	+

9 Some ΔH_c values are given below.

Substance	ΔH_c / kJ mol^{-1}
H_2 (g)	–285
C (s)	–394

What is the ratio of heat generated by hydrogen to that of carbon if the same mass of each substance is burned?

A 0.7 **B** 1.4 **C** 3.4 **D** 4.3

10 Some information about some of the elements of Period 5 of the Periodic Table is shown.

element	Rb	Sr	In	Sn	Sb	Te	I	Xe
Electrical conductivity	high	high	high	high	high	Semi-conductor	zero	zero
Boiling point/ K	961	1650	2300	2540	1650	1260	457	165

Which statement about these elements is correct?

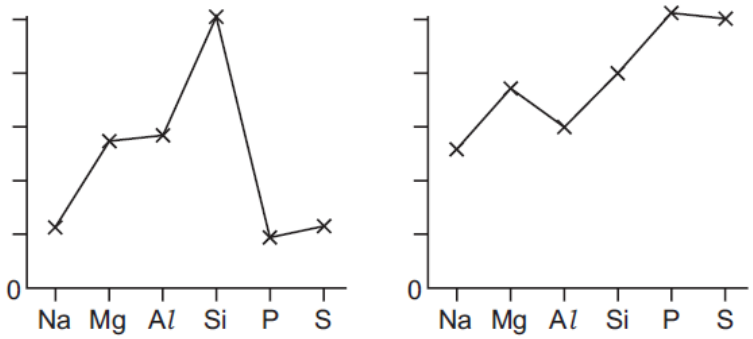
A Te exists as a giant metallic structure with electrostatic forces of attraction.

B TeI_2 exists as an ionic compound with strong electrostatic forces of attraction.

C There are more elements with metallic structures in Period 5 than in Period 3.

D Those elements in Period 5 which have a boiling point under 1000 K exist as simple molecules.

11 The trends in two physical properties of the elements Na, Mg, A*l*, Si, P and S are shown in the following graphs.



Graph 1 **Graph 2**

Which of the following illustrates the correct physical property for the corresponding graphs above?

	Graph 1	**Graph 2**
A	melting point	electrical conductivity
B	1st ionisation energy	electrical conductivity
C	melting point	1st ionisation energy
D	1st ionisation energy	melting point

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

Which of the following statements is correct for Group 2 elements and its compounds?

A Magnesium is kept in oil as it is more reactive while barium is kept in the open.

B Barium reacts with chlorine more spontaneously than magnesium as it has a higher reducing power.

C The rate of decomposition is slower for strontium carbonate than barium carbonate.

D The volume of CO_2 produced is the same when the same mass of strontium carbonate and barium carbonate are decomposed.

13 The reaction of nitrogen oxide and hydrogen involves the following steps:

$$2NO + H_2 \rightarrow N_2O + H_2O \quad \text{(slow)}$$

$$N_2O + H_2 \rightarrow N_2 + H_2O \quad \text{(fast)}$$

Which of the following statements is **incorrect** based on the information above?

A A redox reaction occurs in the slow step.

B It is a second order reaction with respect to [NO].

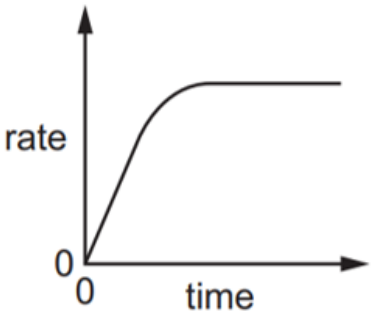
C The units of the rate constant is $mol^{-3}\,dm^{9}\,s^{-1}$.

D N_2O is not present in the overall equation.

14 An autocatalytic reaction is a reaction in which one of the products catalyses the reaction.

Which curve would be obtained if the rate of an autocatalytic reaction is plotted against time?

A



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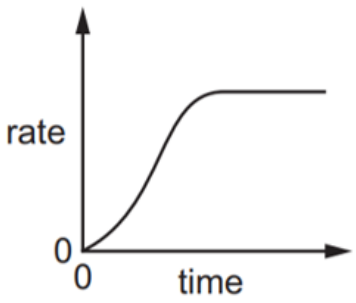

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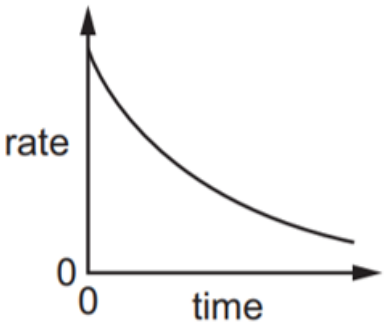

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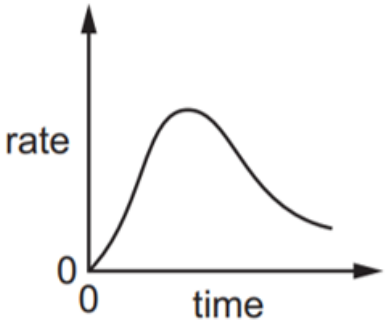
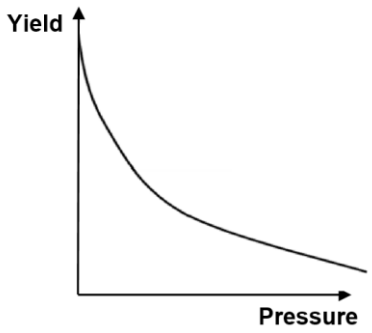


15 Ammonia can be synthesised directly using a mixture of hydrogen gas and nitrogen gas in a reversible reaction as shown:

$$3H_2(g) + N_2(g) \rightleftharpoons 2NH_3(g)$$

Which one of the following describes the change in yield of ammonia at equilibrium as pressure increases?

A



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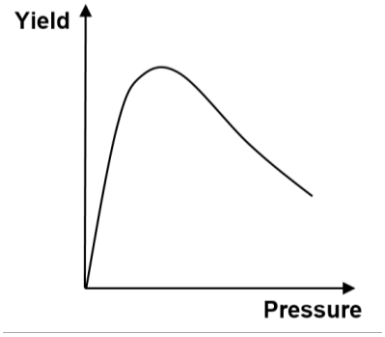

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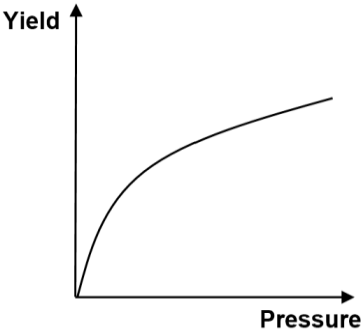

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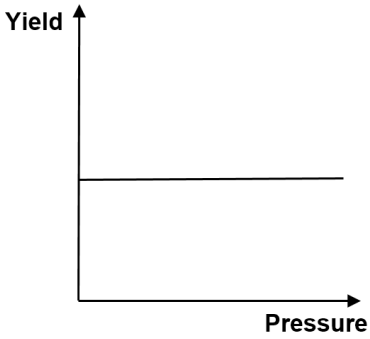


16 Which of the following mixtures are Brønsted-Lowry acid and its conjugate base pair?

1 H_2O and OH^-

2 $H_2PO_4^-$ and HPO_4^{2-}

3 NaH and Na

A 1, 2 and 3 only

B 1 and 2 only

C 2 and 3 only

D 2 only

17 Solutions **E**, **F**, **G** and **H** contain a strong monobasic acid, a weak monobasic acid HX, a strong base and a salt of HX, but not necessarily in the same order. The concentration and pH at 25 °C for each solution are shown below.

Solution	Concentration /mol dm^{-3}	pH
E	1.0	4.0
F	1.0	9.4
G	0.01	12.0
H	0.01	2.0

Which one of the following produces an acidic buffer?

A Mixing 10 cm^3 of **E** and 50 cm^3 of **G**

B Mixing 10 cm^3 of **E** and 50 cm^3 of **H**

C Mixing 10 cm^3 of **F** and 1 dm^3 of **H**

D Mixing 10 cm^3 of **F** and 1 dm^3 of **G**

18 How many tertiary alcohols have the molecular formula $C_6H_{14}O$?

A 1

B 2

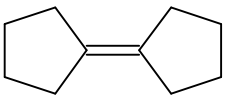
C 3

D 4

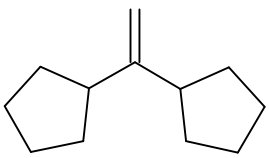
19 Oxidation of an alkene **W** gives a diol; further oxidation gives a diketone.

Which one of the following could be **W**?

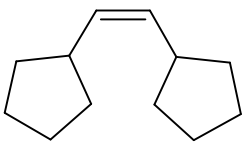
A



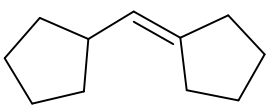
B



C

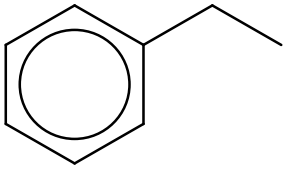
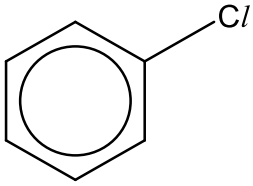
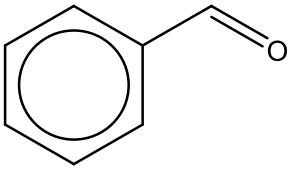


D

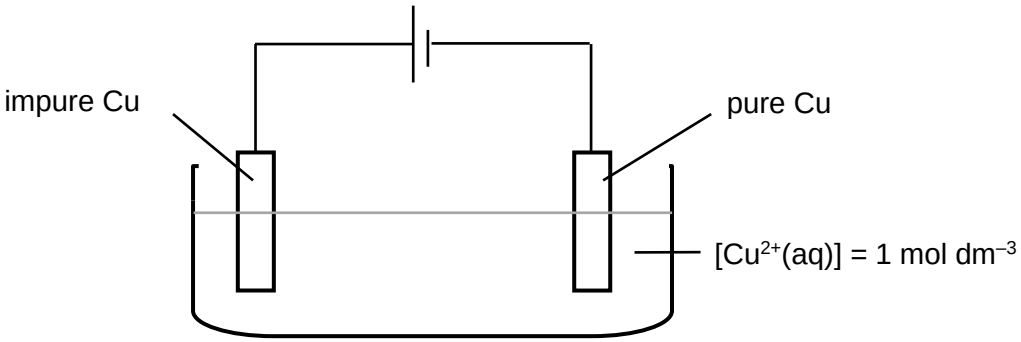


20 *Use of the Data Booklet is relevant for this question*.

Which of the following temperatures and positions of substitution (relative to the substituent) is most suitable for **E**, **F**, **G** to form mono-nitrated products?

	E	**F**	**G**
			
A	> 55°C 2 or 4 - directing	> 55°C 2 or 4 - directing	> 55°C 2 or 4 - directing
B	> 55°C 2 or 4 - directing	> 55°C 3 - directing	> 55°C 2 or 4 - directing
C	< 55°C 2 or 4 - directing	> 55°C 2 or 4 - directing	> 55°C 3 - directing
D	< 55°C 2 or 4 - directing	> 55°C 3 - directing	> 55°C 3 - directing

21 An electrolytic cell is set up for the purification of a mass of impure copper as shown.



The sample of impure Cu is known to contain nickel and silver as minor impurities.

Which of the following factors, when used in a larger quantity, results in more pure copper deposit on the cathode?

A concentration of Cu^{2+} electrolyte

B mass of impure Cu

C temperature

D current

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

Hydrazine (N_2H_4) can be used to reduce metal ions to their elemental forms in the treatment of wastewater. An important half-equation involving hydrazine is shown.

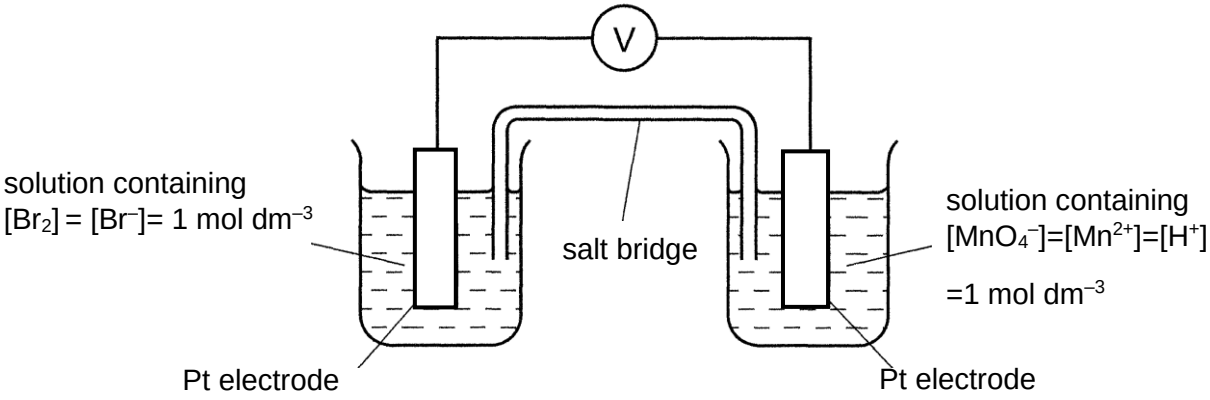
$$N_2 + 4H_2O + 4e^- \rightleftharpoons 4OH^- + N_2H_4 \qquad E^\ominus = -1.17\ V$$

Which of the following ions **cannot** be removed from wastewater by hydrazine?

A Pb^{4+} **B** Co^{3+} **C** Sn^{2+} **D** V^{2+}

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

The following electrochemical cell was set up at 25 °C.



Which of the following statements are true?

1 When silver nitrate crystals are added to the Br_2/Br^- half cell, E_{cell} becomes more positive.

2 The $\Delta G^\ominus$ of the above reaction is – 434 kJ mol^{-1}.

3 Addition of water to the MnO_4^-/Mn^{2+} half-cell has no effect on the E_{cell} of the cell.

A 1 only

B 2 only

C 1 and 2 only

D 2 and 3 only

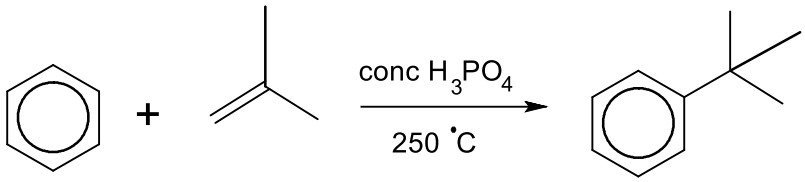
24 An organic molecule has

- the composition, by mass, C, 40%; H, 6.7%; O, 53.3%,
- the ability to rotate plane-polarised light.

What is the smallest number of carbon atoms this molecule can have?

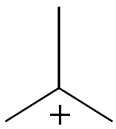
A 1 **B** 2 **C** 3 **D** 4

25 The following industrial reaction involves benzene and 2-methylpropene.



Which of the following intermediate is likely formed in this reaction.

A



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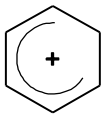
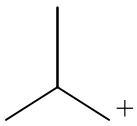


C



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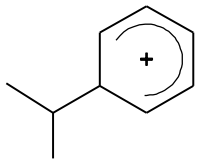
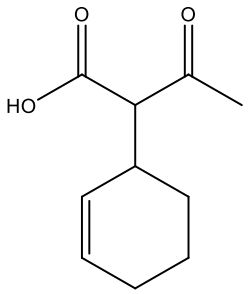
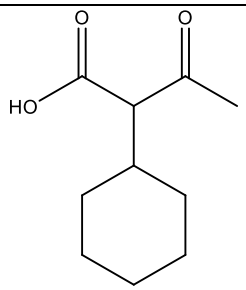
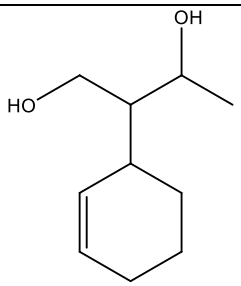
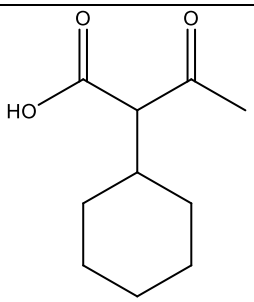
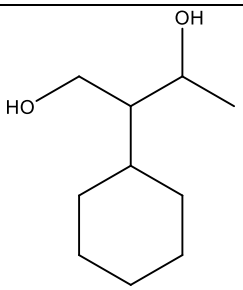
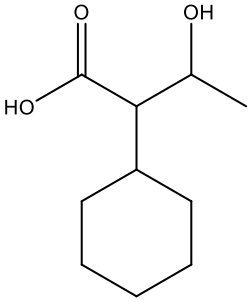
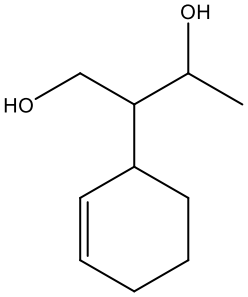
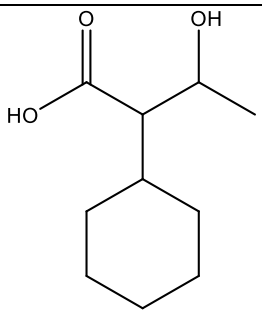
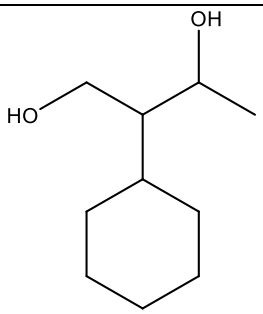


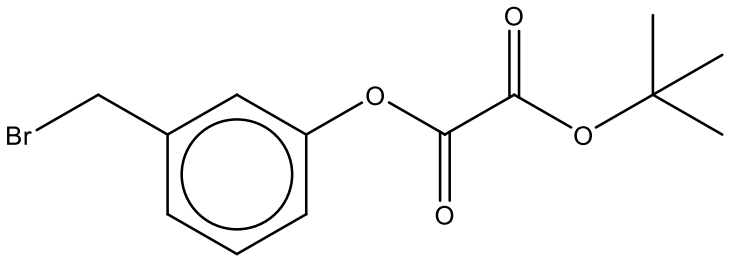
26 Which are the products formed when compound **X** reacts with the following reducing agents?



compound **X**

	H_2, Pt	LiA/H_4 in dry ether
A		
B		
C		
D		

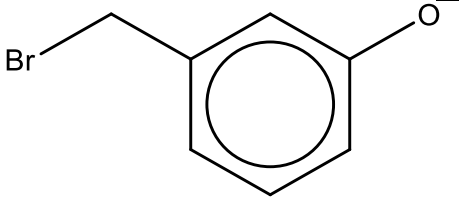
27 Compound **Y** reacts with hot alkaline aqueous manganate(VII).



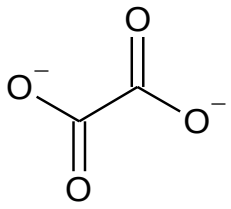
Compound **Y**

Which structure represents the organic product formed?

A



B



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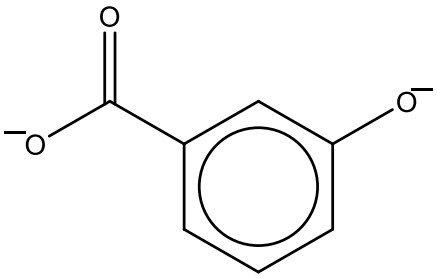

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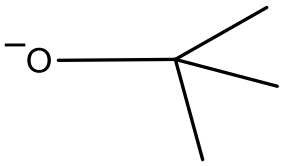


28 Benzylamine has the formula $C_6H_5CH_2NH_2$ and is a common precursor in organic synthesis.

Which statements about benzylamine is correct?

A It can only be formed by the reduction of C_6H_5CN by $LiAlH_4$.

B It reacts with CH_3CO_2H to form $C_6H_5CH_2NHCOCH_3$.

C It is formed by the reaction between $C_6H_5NO_2$ and tin in concentrated HCl.

D It reacts with excess CH_3CH_2Cl under heat to form the compound, $C_{13}H_{22}NCl$.

29 Chiral bromoalkanes can undergo nucleophilic substitution with ethanolic KCN. The reaction mechanism is either S_N1 or S_N2.

Which statements are **incorrect**?

1 Inversion of configuration occurs in S_N2 mechanism.

2 KCN is involved in the rate determining step of S_N1.

3 Racemisation can occur in S_N1 mechanism.

4 The hydrolysis of primary bromoalkanes take place in S_N1 mechanism because there is very little steric hindrance bewteen the nucleophile and the bromoalkanes.

A 1 and 2 only

B 2 and 4 only

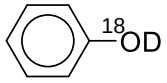
C 2 and 3 only

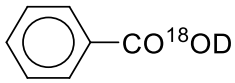
D 1 and 3 only

30 Phenyl propanoate undergoes acid hydrolysis in the presence of a solution containing $D_2{}^{18}O$.

Which of the following products are formed?

1 $CH_3CH_2CO^{18}OD$

2 

3 

A 1 only

B 1 and 2 only

C 1 and 3 only

D 1, 2 and 3 only

End of Paper