CATHOLIC JUNIOR COLLEGE
JC2 PRELIMINARY EXAMINATIONS
Higher 2

CHEMISTRY

9647/01

Paper 1 Multiple Choice

Wednesday 3 September 2014
1 hour

Additional Materials: Multiple Choice Answer Sheet
Data Booklet

READ THESE INSTRUCTIONS FIRST

Write your name and HT group on the Answer Sheet in the spaces provided.
Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.

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 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.

Section A

For each question there are ***four*** possible answers, ***A***, ***B***, ***C*** and ***D***. Choose the one you consider to be ***correct*** and record your choice in soft pencil on the ***separate Answer Sheet*** provided.

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

Which one of the following has the same number of the stated particle as atoms in 127 g of iodine at room conditions?

A number of atoms in 79 g of gold

B number of anions in 0.5 mol of barium chloride

C number of ions in 1 mol of potassium bromide

D number of molecules in 10 g of hydrogen fluoride

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

In polluted air, the white paint pigment in older oil paintings forms lead(II) sulfide, PbS, that is black in colour. To restore the white colour, an oxidising agent, hydrogen peroxide, H_2O_2, is used.

Given that 0.239 g of PbS requires 25 cm^3 of 0.160 mol dm^{-3} H_2O_2 for oxidation, what is the possible identity of the white paint pigment?

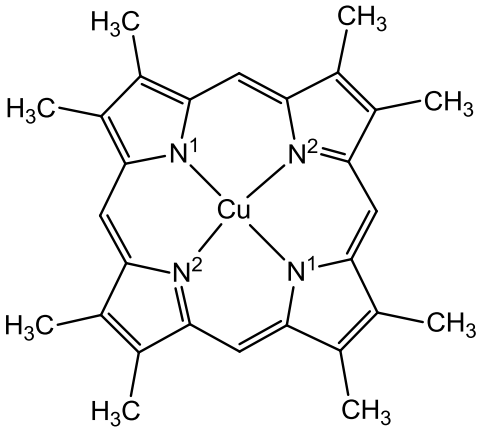
A S_8 **B** PbS_2 **C** $PbSO_3$ **D** $PbSO_4$

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

Which one of the following species has more neutrons than electrons and more electrons than protons?

A $^{37}Cl^-$ **B** $^{48}Ti^{4+}$ **C** $^{79}Br^+$ **D** $^{32}S^{2-}$

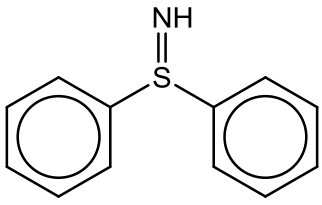
4 In recent years, many scientists have been researching the potential of copper complexes as drugs in chemotherapy due to their ability to inhibit cell proliferation and induce apoptosis in cells. An example of such a complex is shown below:



Which one of the following best describes the bonds formed with Cu?

	Cu-N^1	**Cu-N^2**
A	dative	π
B	π	ionic
C	ionic	dative
D	σ	π

5 What is the most likely bond angle of the sulfur atom in S,S-diphenylsulfilimine?

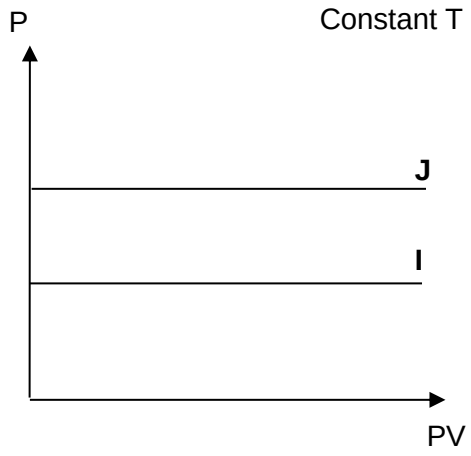


S,S-diphenylsulfilimine

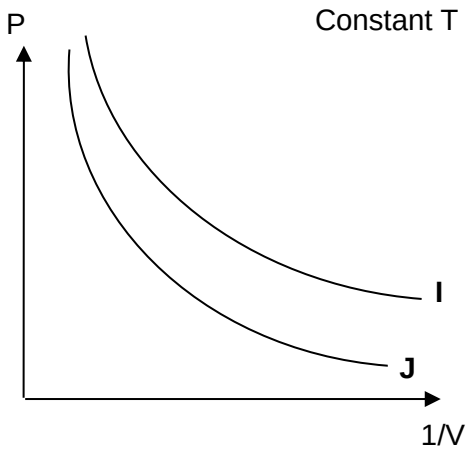
A 90° **B** 107° **C** 109° **D** 120°

6 Which graph correctly describes the behaviour of fixed masses of the ideal gases **I** and **J**, where **I** has a higher M_r than **J**?

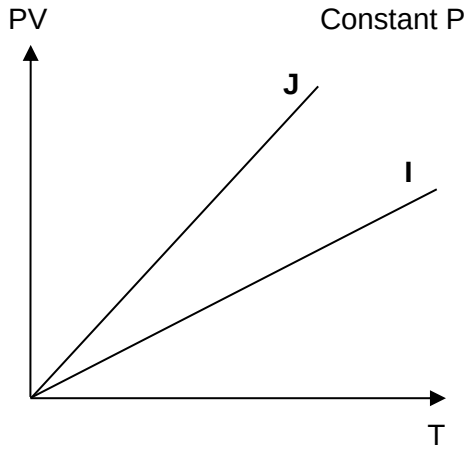
A



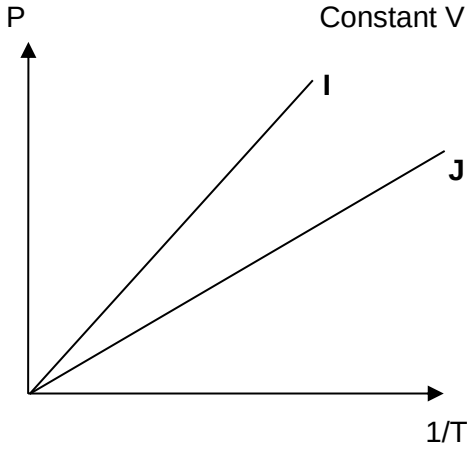
B



C



D



7 Fe^{3+} and SCN^- react in a closed system to give the complex, $[Fe(SCN)]^{2+}$, which is blood-red in colour.

$$Fe^{3+}(aq) + SCN^-(aq) \rightleftharpoons [Fe(SCN)]^{2+}(aq) \qquad \Delta H < 0$$

Which one of the following changes will result in the solution turning pale red?

A Increase the concentration of SCN^-.

B Decrease the pressure of the system.

C Decrease the temperature of the system.

D Add a small amount of dilute NaOH(aq) to the resulting mixture.

8 Solid NaC*l* dissolves in water to give $Na^+(aq)$ and $Cl^-(aq)$ ions under standard conditions of 298 K, 1 atm.

$$NaCl(s) \rightarrow Na^+(aq) + Cl^-(aq)$$

$Na^+(g) + Cl^-(g) \rightarrow NaCl\ (s)$	$\Delta H_{latt}^{\ominus} = -781\ kJ\ mol^{-1}$
$Na^+(g) \rightarrow Na^+(aq)$	$\Delta H_{hyd}^{\ominus} = -390\ kJ\ mol^{-1}$
$Cl^-(g) \rightarrow Cl^-(aq)$	$\Delta H_{hyd}^{\ominus} = -381\ kJ\ mol^{-1}$

What is the standard enthalpy change of solution, $\Delta H_{sol}^{\ominus}$, for the above reaction?

A $-10\ kJ\ mol^{-1}$ **B** $+10\ kJ\ mol^{-1}$ **C** $-20\ kJ\ mol^{-1}$ **D** $+20\ kJ\ mol^{-1}$

9 What is the pH of the resulting solution when 2.50 g of NH_4Cl is dissolved in 250 cm^3 of 0.100 mol dm^{-3} $NH_3(aq)$? [K_b of $NH_3 = 1.8 \times 10^{-5}$ mol dm^{-3}]

A 5.01 **B** 8.99 **C** 9.53 **D** 14.0

10 Equal volumes of aqueous KI and 0.200 mol dm^{-3} of $Pb(NO_3)_2$ are mixed together to precipitate PbI_2. Given that the K_{sp} value of PbI_2 is 8.70×10^{-9} $mol^3\ dm^{-9}$, which one of the following could have been the initial concentration of KI?

A 8.70×10^{-8} mol dm^{-3}

B 2.95×10^{-4} mol dm^{-3}

C 5.90×10^{-4} mol dm^{-3}

D 1.50×10^{-2} mol dm^{-3}

11 Two electrode potentials are given below:

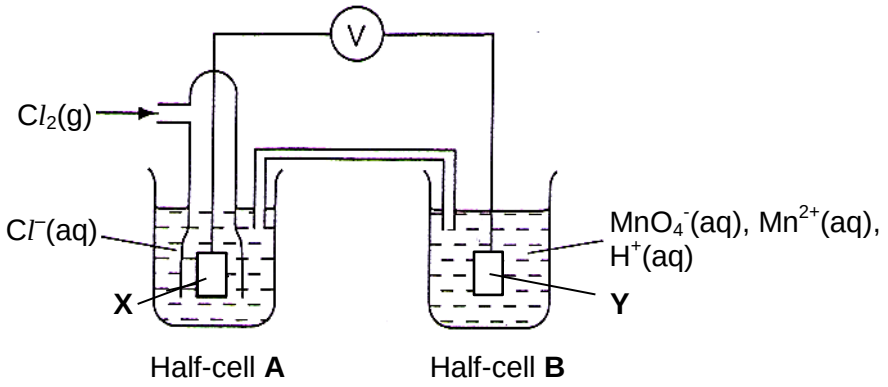
$$Co^{3+} + e^- \rightleftharpoons Co^{2+} \qquad E^{\ominus} = +1.82\ V$$
$$Sn^{4+} + 2e^- \rightleftharpoons Sn^{2+} \qquad E^{\ominus} = +0.15\ V$$

Which species is the strongest reducing agent?

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

12 *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 one of the following statements is correct?

A Addition of $AgNO_3$(aq) to half-cell **A** will not affect $E_{cell}^{\ominus}$.

B The voltmeter will show a reading of about +1.52 V.

C The electrons will flow from **X** to **Y** through the voltmeter.

D **Y** will be the negative electrode.

13 Hydrogen peroxide reacts with iodide ions in acidic solution as follows:

$$H_2O_2(aq) + 2\ H^+(aq) + 2\ I^-(aq) \rightarrow 2\ H_2O(l) + I_2(aq)$$

The rate equation was found experimentally to be: rate = $k[H_2O_2][I^-]$.

Which mechanism is consistent with the kinetics of this reaction?

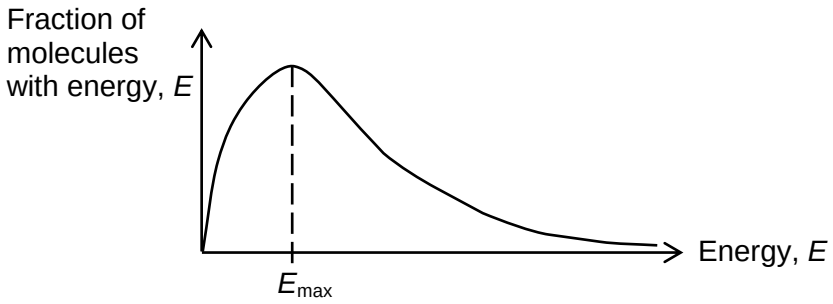
A
$H_2O_2 + H^+ \rightarrow H_2O + OH^+$ (fast)
$H^+ + OH^+ + 2\ I^- \rightarrow H_2O + I_2$ (slow)

B
$2\ H^+ + 2\ I^- \rightarrow 2\ HI$ (fast)
$2\ HI + H_2O_2 \rightarrow I_2 + 2\ H_2O$ (slow)

C
$H_2O_2 + I^- \rightarrow H_2O + IO^-$ (slow)
$H^+ + IO^- \rightarrow HIO$ (fast)
$HIO + H^+ + I^- \rightarrow I_2 + H_2O$ (fast)

D
$H_2O_2 + I^- + H^+ \rightarrow H_2O + HIO$ (fast)
$HIO + I^- \rightarrow I_2 + OH^-$ (slow)
$OH^- + H^+ \rightarrow H_2O$ (fast)

14 The diagram shows the Boltzmann distribution of molecular energies of a gas at a given temperature.



Which one of the following statements correctly describes what happens as temperature increases?

A The activation energy of the reaction is lowered.

B The maximum of the curve is displaced to the left.

C The proportion of molecules with $E < E_{max}$ increases.

D The proportion of molecules with energies above any given value increases.

15 For the oxides of Period 3 elements (Na to P), which property decreases from Na_2O to P_4O_{10}?

A covalent character

B melting point

C pH when mixed with water

D solubility in aqueous alkali

16 Which property of strontium, a Group II element, and its compounds is correct?

A Strontium does not burn in air.

B Strontium does not react with steam.

C Strontium hydroxide produces strontium oxide when heated strongly.

D Strontium nitrate decomposes at a lower temperature than calcium nitrate.

17 Which one of the following statements is most likely to be true for astatine, the element below iodine in Group VII of the Periodic Table?

A Potassium astatide and hot dilute sulfuric acid react to form white fumes of hydrogen astatide.

B Astatine and aqueous potassium chloride react to form aqueous potassium astatide and chlorine.

C Sodium astatide and hot concentrated sulfuric acid react to form astatine.

D Silver astatide and dilute aqueous ammonia react to form a solution of a soluble complex.

18 The hexa-aquairon(III) ion hydrolyses as shown below.

$$[Fe(H_2O)_6]^{3+}(aq) + H_2O(l) \rightleftharpoons [Fe(H_2O)_5OH]^{2+}(aq) + H_3O^+(aq)$$

Which one of the following statements is correct?

A The hydrolysis is favoured by low pH.

B An aqueous solution of $FeCl_3$ is alkaline.

C The iron undergoes a change in oxidation state from +3 to +2.

D The corresponding hexa-aquairon(II) ion, $[Fe(H_2O)_6]^{2+}(aq)$ is relatively less likely to undergo hydrolysis.

19 Which one of the following is an optically active compound and is soluble in water?

A $CH_3CH=CHCO_2H$

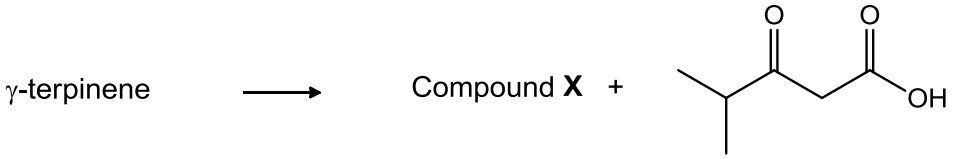
B $CH_3CH=C(CH_3)_2$

C $CH_3CH_2CHBrCH_3$

D $CH_3CH(OH)CO_2H$

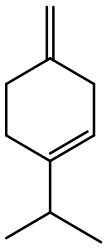
20 γ-Terpinene is a naturally-occurring hydrocarbon and has been isolated from a variety of plant sources.

On treatment of γ-terpinene with an excess of hot concentrated manganate(VII) ions, two organic products are formed. It was found that compound **X** evolves CO_2 with Na_2CO_3, gives an orange precipitate with 2,4-dinitrophenylhydrazine and a yellow precipitate with alkaline aqueous iodine.



Which one of the following shows a possible structure for γ-terpinene?

A



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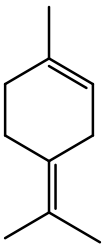
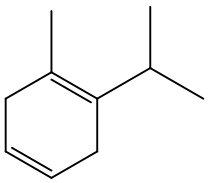
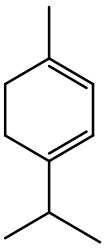


C



D



21 The following reaction scheme outlines the production of one of the monomers of nylon-6,6, hexane-1,6-diamine, from 1,4-dibromobutane.

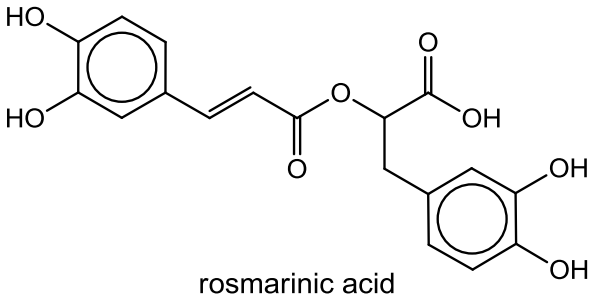
$BrCH_2CH_2CH_2CH_2Br \xrightarrow{\textbf{Step I}} NCCH_2CH_2CH_2CH_2CN \xrightarrow{\textbf{Step II}} H_2N(CH_2)_6NH_2$

1,4-dibromobutane hexane-1,6-diamine

Which one of the following shows the reagents and conditions for each step?

	Step I	**Step II**
A	alcoholic NH_3, heat	aqueous KOH, room temperature
B	alcoholic KCN, heat	aqueous NaOH, heat
C	HCN, with trace amount of KCN, 10-20 °C	$LiAlH_4$ in dry ether
D	alcoholic KCN, heat	H_2, Ni catalyst, heat

22 Rosmarinic acid occurs in culinary herbs such as rosemary, sage and thyme.



rosmarinic acid

Which one of the following statements about rosmarinic acid is true?

A 1 mole of rosmarinic acid reacts with 6 moles of hot aqueous NaOH.

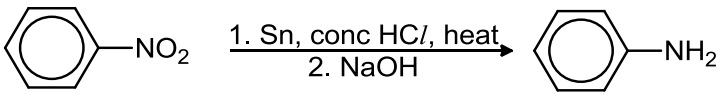
B Rosmarinic acid gives an orange precipitate with 2,4-dinitrophenylhydrazine.

C When rosmarinic acid is heated with ethanoic acid and concentrated H_2SO_4, an ester is formed.

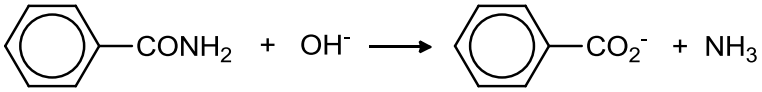
D When reacted with $LiAlH_4$, each molecule of rosmarinic acid would incorporate 4 hydrogen atoms.

23 The nitrogen present in compounds can react in various ways. In which one of the following reactions is nitrogen acting as a nucleophile?

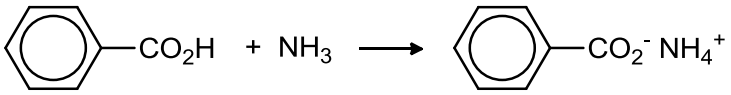
A



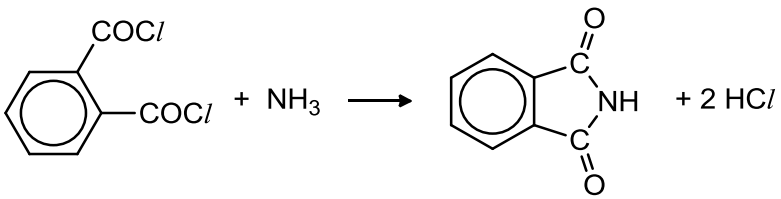
B



C



D



24 Which one of the following statements is true about S_N1 and S_N2 mechanisms?

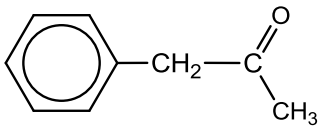
A S_N1 is a one-step reaction.

B S_N1 will cause an inversion in the configuration.

C S_N2 results in the formation of a carbocation intermediate.

D S_N2 is more likely to occur for $CH_3CH_2CH_2CH_2Cl$ as compared to $CH_3C(Cl)(CH_3)_2$.

25 Phenylpropanone is used in the manufacture of methamphetamine and amphetamine. A molecule of phenylpropanone is shown below:



Which one of the following is a correct observation when phenylpropanone reacts with the respective reagents?

A When added to aqueous bromine, orange aqueous bromine decolorises.

B When heated with aqueous alkaline iodine, no yellow precipitate is formed.

C When heated with acidified $KMnO_4$, purple $KMnO_4$ decolorises.

D When heated with Tollens' reagent, a silver mirror is formed.

26 Which pair of the following reactions would produce the same intermediate?

I $CH_3CH(OH)CH_3 \rightarrow$ intermediate $\rightarrow CH_3C(OH)CNCH_3$

II $CH_3CH{=}CH_2 \rightarrow$ intermediate $\rightarrow CH_3CH(CN)CH_3$

III $(CH_3)_2C{=}CH_2 \rightarrow$ intermediate $\rightarrow CH_3CH(OH)CH_3$

IV $CH_3CH_2CH_2OH \rightarrow$ intermediate $\rightarrow CH_3CH_2CH(OH)CN$

A **I** and **II**

B **I** and **III**

C **II** and **IV**

D **III** and **IV**

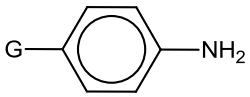
27 Which one of the following statements best explains why CH_3CH_2COCl readily hydrolyses in water but $CH_3CH_2CO_2CH_3$ does not?

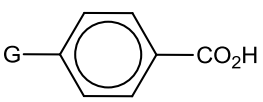
A The C=O bond in CH_3CH_2COCl is more polar and thus weaker than that in $CH_3CH_2CO_2CH_3$.

B The C*l* atom in CH_3CH_2COCl is more electronegative than the O atom in the $–OCH_3$ in $CH_3CH_2CO_2CH_3$.

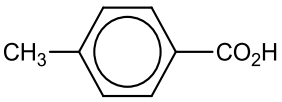
C The carbonyl carbon in CH_3CH_2COCl has a larger partial positive charge as compared to that in $CH_3CH_2CO_2CH_3$.

D There are more electrons on C*l* atom in CH_3CH_2COCl as compared to the O atom in the $–OCH_3$ in $CH_3CH_2CO_2CH_3$.

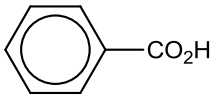
28 Given that  is a weaker base than phenylamine, what is the relative order of **decreasing** acidity of the three compounds shown below?



I



II



III

A **I** > **III** > **II**

B **II** > **I** > **III**

C **II** > **III** > **I**

D **III** > **I** > **II**

29 Partial hydrolysis of a tetrapeptide produces alanine, glycine and the following dipeptides.

Dipeptide 1: Ala-Gly

Dipeptide 2: Ala-Ala

Dipeptide 3: Gly-Ala

Which one of the following is not a possible identity of this tetrapeptide?

A Ala-Ala-Gly-Ala

B Ala-Ala-Ala-Gly

C Ala-Gly-Ala-Ala

D Gly-Ala-Ala-Gly

30 Which salt will be the most acidic in aqueous solution?

A $CH_3CH_2NH_3^+Cl^-$

B $C_6H_5NH_3^+Cl^-$

C Na^+Cl^-

D $CH_3CO_2^-Na^+$

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 that 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 Which of the following statements is correct about the complete combustion of an alkene, C_nH_{2n}, in oxygen?

1 The volume of oxygen required is directly proportional to the number of carbon atoms present in the molecule.

2 The volume of gas produced at 25 ^oC is the same as for the complete combustion of an alkane, C_nH_{2n+2}.

3 At 120 ^oC, the volume of steam produced is twice the volume of carbon dioxide.

32 Which of the following is an endothermic process?

1 the condensation of steam

2 the electrolysis of water

3 the sublimation of iodine

33 Which of the following are correct statements about a catalysed reversible reaction?

1 The catalyst alters the composition of equilibrium mixture.

2 The catalyst alters the mechanism for the reaction.

3 The catalyst reduces the activation energy for both the forward and backward reactions.

34 Which properties of aluminium chloride are related to its lack of an octet configuration in the A*l* atom?

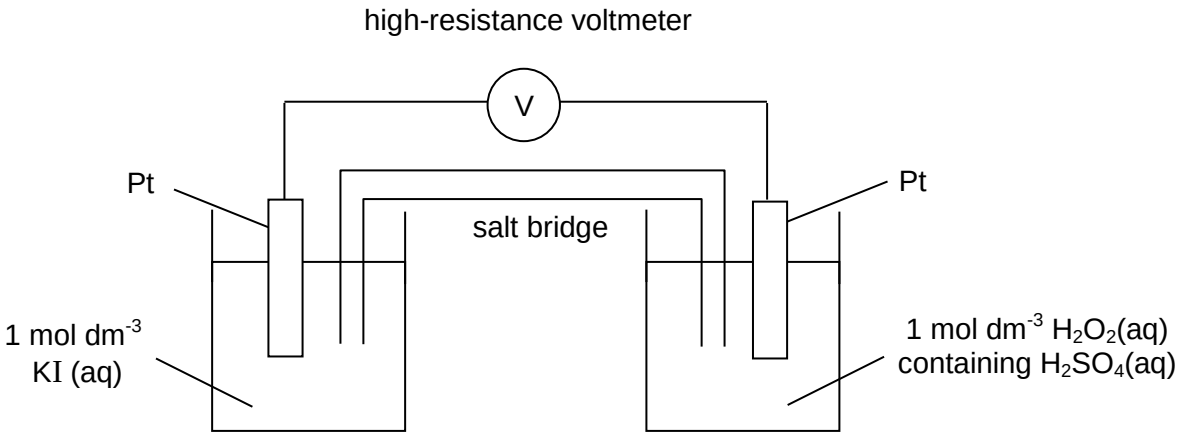
1 its tendency to dimerise

2 its covalent character

3 its acidity in aqueous solution

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

An electrochemical cell is shown below.



Which of the following observations apply to the above cell?

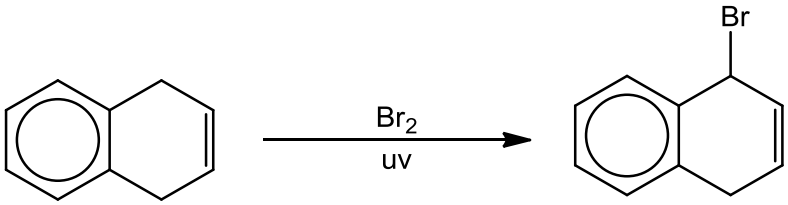
1 The KI(aq) solution turns brown.

2 The $E^{\ominus}_{cell}$ value is +0.14 V.

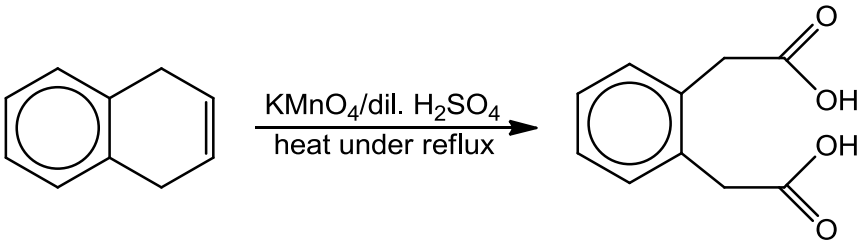
3 Effervescence is observed in the H_2O_2 half-cell.

36 Which of the following reactions will not give a good yield of the desired product?

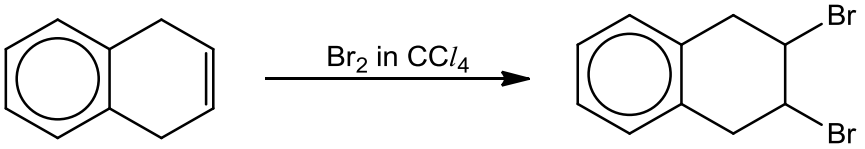
1

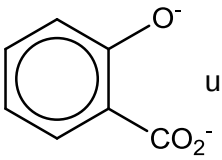


2

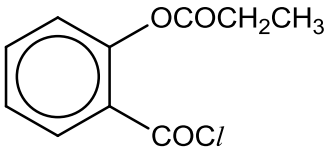


3



37 Which compound will produce  upon reaction with hot aqueous sodium hydroxide?

1



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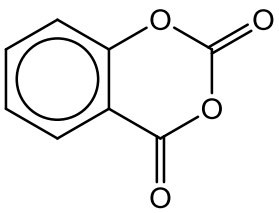

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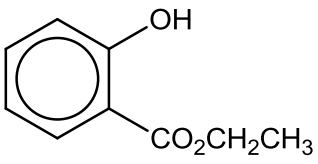
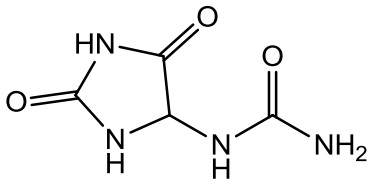


38 Allantoin is known to have a soothing and moisturizing effect on human skin and is commonly included in cosmetics and skincare products.



allantoin

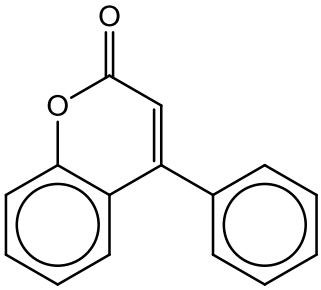
Which of the following is true of allantoin?

1 It is optically inactive.

2 An aqueous solution of allantoin is approximately neutral.

3 Hydrolysis of allantoin gives an α-amino acid as one of the products.

39 Which deductions about the reactions of 4-phenylcoumarin can be made from its structure?



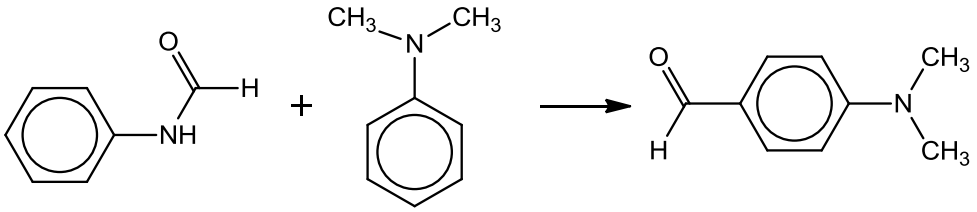
4-phenylcoumarin

1 Upon hydrolysis, the organic product reacts with 3 moles of Br_2(aq).

2 It reacts with cold acidified $KMnO_4$ to give a chiral product.

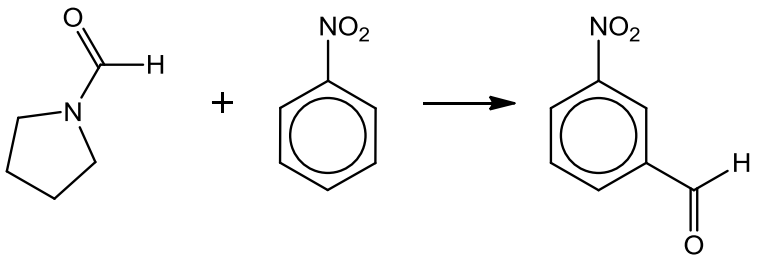
3 It can undergo both nucleophilic substitution and nucleophilic addition.

40 The Vilsmeier-Haack reaction is the chemical reaction of an amide with an electron-rich arene to produce an aryl aldehyde or ketone. The reaction occurs with the aid of phosphorus oxychloride, $POCl_3$, (which is not shown) in the equation below:

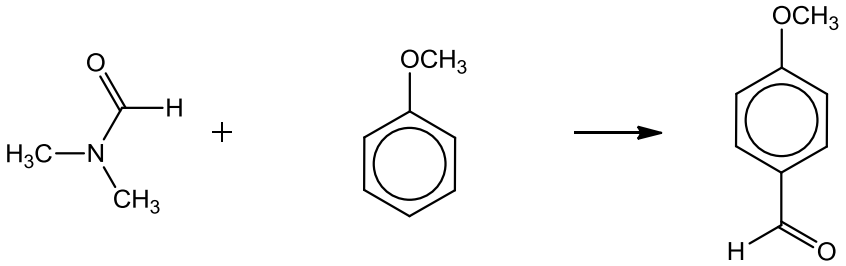


Which of the following is an example of a Vilsmeier-Haack reaction?

1



2



3