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ST ANDREW'S JUNIOR COLLEGE



JC2 Preliminary Examination

H2 Chemistry (9729)

19 Sep 2019

Paper 1 Multiple Choice

1 hour

Additional Materials: Multiple Choice Answer Sheet, Data Booklet

READ THESE INSTRUCTIONS:

Write in soft pencil.

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

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 **14** printed pages (including this page).

1 Which statement about one mole of sodium metal is always true?

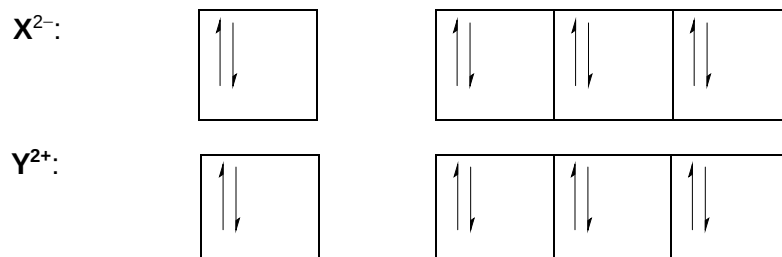
- A It has the same mass as one mole of ^{12}C .
- B It has the same number of atoms as 18 g of water.
- C It has the same number of atoms as $\frac{1}{12}$ mole of ^{12}C .
- D It has the same number of atoms as 12 dm³ of fluorine gas at r.t.p.

2 0.84 g of an oxide **MO** of a metal **M** was dissolved in excess sulfuric acid. 25.0 cm³ of 0.12 mol dm⁻³ potassium manganate(VII) solution was required to oxidise **M²⁺** to **M³⁺**.

What is the relative atomic mass of **M**?

- A 36.0 B 40.0 C 52.0 D 56.0

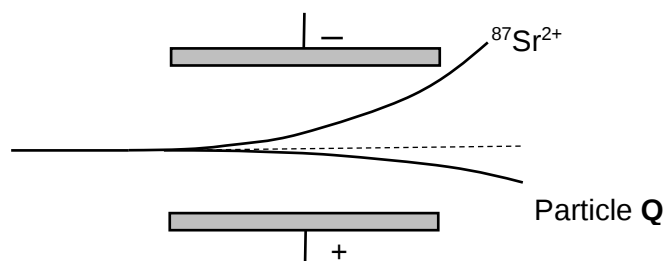
3 **X** and **Y** are elements found in the first three periods of the Periodic Table. The outermost shell electronic configurations of two species are given as follows:



What can best be deduced from the above information?

- A **X** has a larger proton number than **Y**.
- B **X** has more unpaired electrons than **Y** at the ground state.
- C **X** exists as a gas while **Y** is a solid at standard condition.
- D **X²⁻** and **Y²⁺** are isoelectronic.

- 4 In an experiment, a sample of gaseous $^{87}\text{Sr}^{2+}$ was passed through an electric field. The angle of deflection for $^{87}\text{Sr}^{2+}$ was observed to be 2° .



The experiment was repeated with gaseous sample of particle **Q**. Which of the following could be **Q**?

- A** $^{74}\text{As}^{3-}$ **B** $^{19}\text{F}^{-}$ **C** $^{79}\text{Se}^{2-}$ **D** $^{127}\text{Te}^{2-}$

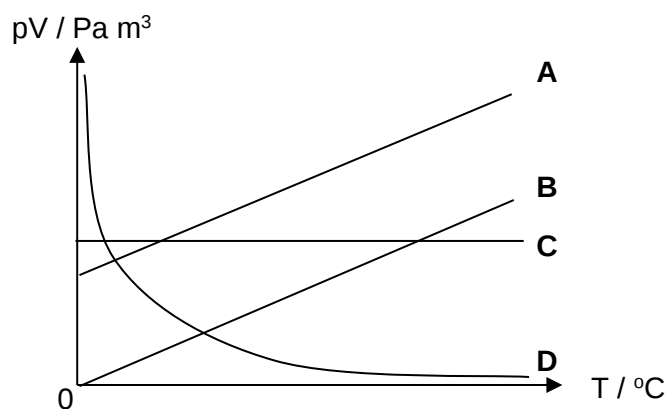
- 5 BeCl_2 reacts with CH_3NH_2 to form compound **Z** ($M_r = 142.0$).

Which of the following statements are correct?

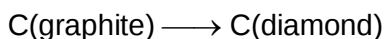
- 1 The hybridisation state of N in **Z** is sp^3 .
- 2 Hydrogen bonds exist between molecules of compound **Z**.
- 3 1 mol of compound **Z** is formed from 1 mol of BeCl_2 and 2 mol of CH_3NH_2 .

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

- 6 Which of the following graphs correctly describes the variation of pV with temperature for a fixed amount of an ideal gas?



- 7 The conversion of graphite into diamond is an endothermic reaction.



Which of the following statements are correct?

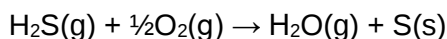
- 1 The carbon-carbon bonds in graphite are stronger than that in diamond.
- 2 The activation energy of the conversion of graphite to diamond is larger than that of the reverse reaction.
- 3 The enthalpy change of atomisation of diamond is less endothermic than that of graphite.
- 4 The enthalpy change of combustion of diamond is less exothermic than that of graphite.

- A** 1 and 2 only **B** 1 and 3 only
C 1, 2 and 3 only **D** 1, 2 and 4 only

- 8 Given the following enthalpy changes:

	$\Delta H / \text{kJ mol}^{-1}$
Enthalpy change of formation of $\text{H}_2\text{S}(\text{g})$	-20.6
Enthalpy change of formation of $\text{H}_2\text{O}(\text{l})$	-286.0
Enthalpy change of vaporisation of $\text{H}_2\text{O}(\text{l})$	+40.7

What is the enthalpy change (in kJ mol^{-1}) of reaction for the following reaction?



- A** -224.7 **B** -265.4 **C** -306.6 **D** -347.3

- 9 Which equation corresponds to the enthalpy change stated?

- A** $\text{H}_2\text{SO}_4(\text{aq}) + 2\text{KOH}(\text{aq}) \rightarrow \text{K}_2\text{SO}_4(\text{aq}) + 2\text{H}_2\text{O}(\text{l})$ $\Delta H_{\text{neutralisation}}^{\theta}$
- B** $\text{Na}^+(\text{s}) + \text{aq} \rightarrow \text{Na}^+(\text{aq})$ $\Delta H_{\text{hydration}}^{\theta}(\text{Na}^+)$
- C** $\text{Al}_2\text{O}_3(\text{s}) \rightarrow 2\text{Al}^{3+}(\text{g}) + 3\text{O}^{2-}(\text{g})$ $\Delta H_{\text{lattice energy}}^{\theta}(\text{Al}_2\text{O}_3)$
- D** $\text{O}_2(\text{g}) \rightarrow 2\text{O}(\text{g})$ $2\Delta H_{\text{atomisation}}^{\theta}(\text{O}_2)$

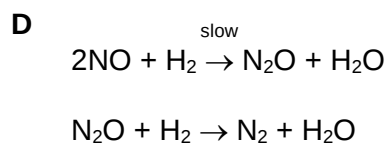
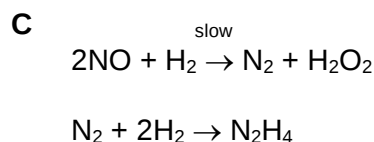
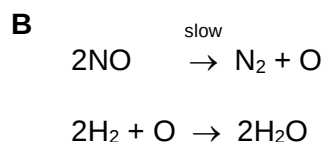
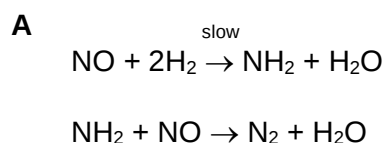
- 10** A chemical plant illegally dumped some radioactive waste in a landfill. This waste composed of two radioactive isotopes **X** and **Y**. The half-life of **X** is 4 days whereas that of **Y** is 2 days. The authorities found out about this illegal dumping only when the waste had been in the landfill for 8 days. They did an immediate analysis on a sample of the waste and found equal amounts of **X** and **Y**.

Considering that the decay of radioactive isotopes follows first-order kinetics, what is the initial molar ratio of **X** to **Y** if the waste had been in the landfill for 4 days?

X : **Y**

- A** 1 : 2
- B** 1 : 4
- C** 2 : 1
- D** 4 : 1
- 11** Hydrogen reacts with nitrogen monoxide to form nitrogen and steam only. The rate equation for this reaction is $\text{rate} = k[\text{NO}]^2[\text{H}_2]$.

Which could be the mechanism for this reaction?



- 12** The table below shows the values of the ionic product of water, K_w , at two different temperatures.

Temperature / °C	K_w / mol ² dm ⁻⁶
25	1.00×10^{-14}
60	1.00×10^{-13}

Which of the following statements is correct for pure water?

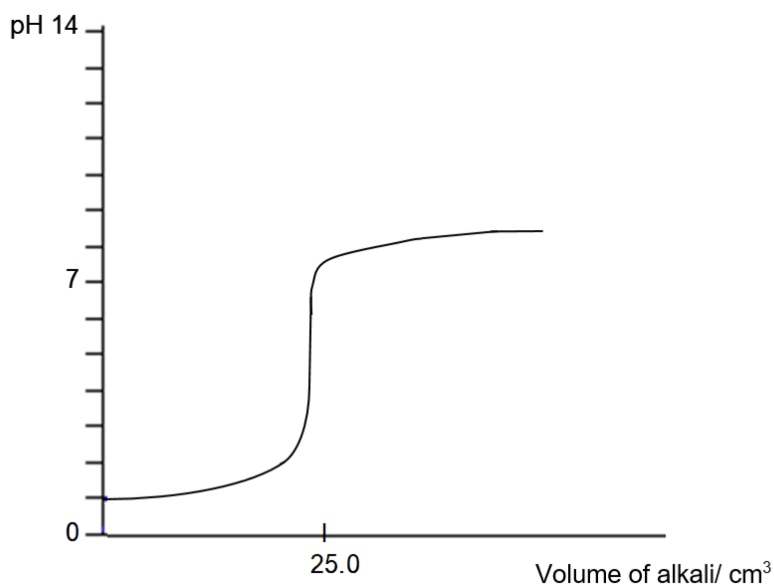
- A** The ionic dissociation of water is an exothermic process.
 - B** At 60 °C, the pH is less than 7.
 - C** At 60 °C, the pH is more than the pOH.
 - D** At 60 °C, the solution becomes more acidic.
- 13** The numerical value of the equilibrium constant, K_c , for the following reaction at 25°C is 1.2×10^5 .



Which statements about the reaction is correct?

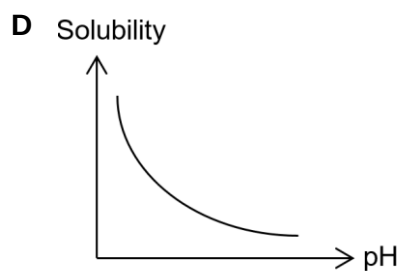
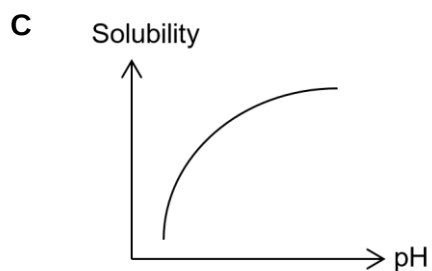
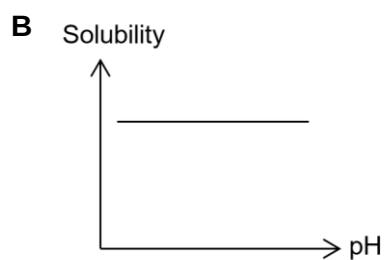
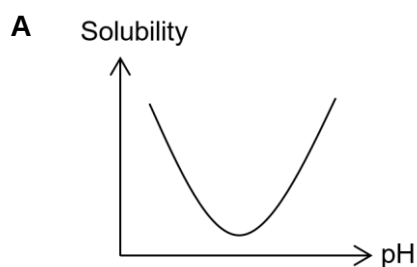
- 1 The units for K_c is mol⁻¹dm³.
 - 2 $\Delta G^\ominus$ is less than zero.
 - 3 The equilibrium position shifts when an inert gas is added at constant volume.
- A** 1 and 3 only
 - B** 2 only
 - C** 2 and 3 only
 - D** 1, 2 and 3

- 14 The graph shows the change in pH when an alkali is gradually added to 25 cm³ of an acid.



Which of the following statements about the titration is correct?

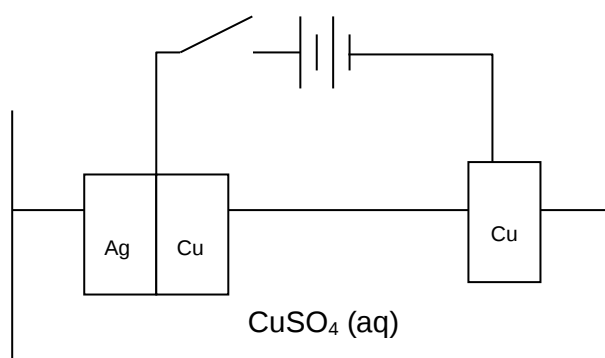
- A Acidic buffer is formed after the equivalence point.
 - B Both phenolphthalein and methyl orange can be used as the indicator for this titration.
 - C This is a titration between 0.10 mol dm⁻³ of HCl(aq) and 0.10 mol dm⁻³ of NH₃(aq).
 - D The maximum buffer capacity occurs when 12.5 cm³ of alkali is added.
- 15 CaF₂ is a sparingly soluble salt and is added to a weakly acidic solution of HF. The pH of the solution is adjusted by adding NaOH. Which diagram shows how the solubility of CaF₂ will vary with the pH of the solution at constant temperature?



- 16** Why is ethanoic acid a stronger acid in liquid ammonia than in aqueous solution?
- A** Ammonium ethanoate is completely ionised in aqueous solution.
B Ammonium ethanoate is strongly acidic in aqueous solution.
C Ammonia is a stronger base than water.
D Liquid ammonia is more polar solvent than water.

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

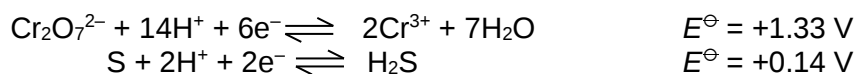
The following circuit with a switch was set up as shown in the diagram:



Which electrode reactions will occur when the switch is closed?

- | Anode reaction | Cathode reaction |
|---|------------------------|
| A Silver dissolves preferentially | Hydrogen is evolved |
| B Copper dissolves preferentially | Copper is precipitated |
| C Silver dissolves preferentially | Copper is precipitated |
| D Silver and copper both dissolve together | Hydrogen is evolved |

- 18** Some relevant redox half-equations are given below:



Which of the following statements are true when hydrogen sulfide is bubbled into acidified aqueous sodium dichromate(VI)?

- 1 The solution turns orange to green.
 - 2 White precipitate is observed.
 - 3 The reaction has a positive entropy change.
- A** 1 only **B** 1 and 2 only
C 1, 2 and 3 **D** None of the statements are true

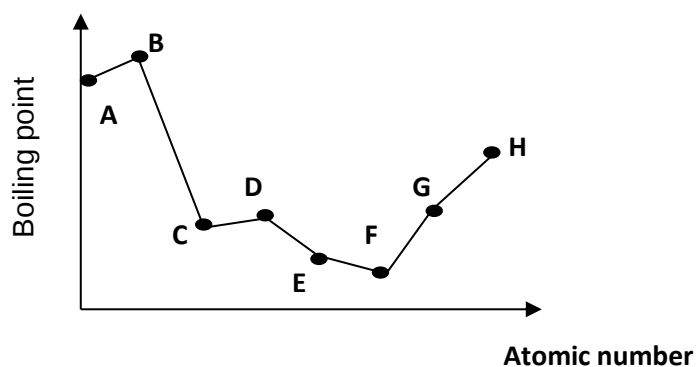
19 Elements **X**, **Y** and **Z** are in Period 3 of the Periodic Table.

- The oxide of **X** gives an aqueous solution of pH less than pH 7.
- The oxide of **Y** reacts with both strong acids and strong alkalis.
- The oxide of **Z** gives an aqueous solution which is strongly alkaline.

What is the order of increasing atomic radius for these elements?

- A** $X < Y < Z$
B $X < Z < Y$
C $Y < Z < X$
D $Z < Y < X$

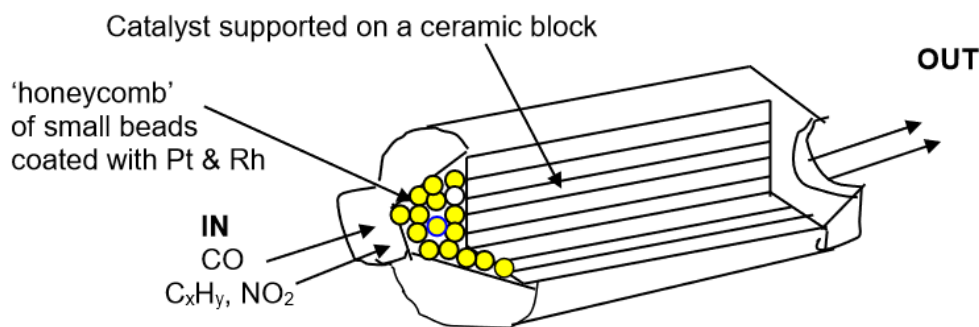
20 The graph below shows the variation in the boiling points for eight consecutive elements in the Periodic Table, all with atomic number between 10 and 20.



Which of the following statements is correct?

- A** Element **G** does not conduct electricity.
B Element **D** forms only one acidic oxide.
C Element **A** and beryllium are in the same group
D Element **C** forms a chloride which hydrolyses readily to give a strongly acidic solution.

- 21** A catalytic converter is part of the exhaust system in modern cars.

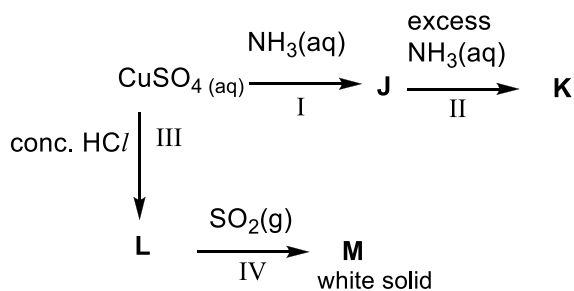


Which of the following statements are true concerning the reactions and processes in the catalytic converter?

- 1 $\text{CO}_2 + \text{NO} \rightarrow \text{CO} + \text{NO}_2$
- 2 $2\text{CO} + 2\text{NO} \rightarrow 2\text{CO}_2 + \text{N}_2$
- 3 $\text{C}_x\text{H}_y + (2x + \frac{y}{2})\text{NO} \rightarrow x\text{CO}_2 + \frac{y}{2}\text{H}_2\text{O} + (x + \frac{y}{4})\text{N}_2$
- 4 Platinum and rhodium catalyse the reactions

- A** 1, 2, 3 and 4 **B** 1 and 2 only
C 2 and 3 only **D** 2, 3 and 4 only

- 22** Copper(II) sulfate solution reacted as shown in the scheme below.

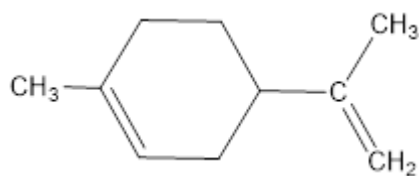


Which of the following statements are correct?

- 1 NH_3 functions as a ligand in reaction I.
- 2 The coordination number of complex **L** is 4.
- 3 The oxidation number of the Cu in **M** is +1.

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

- 23 Limonene is an oil formed in the peel of citrus fruits.

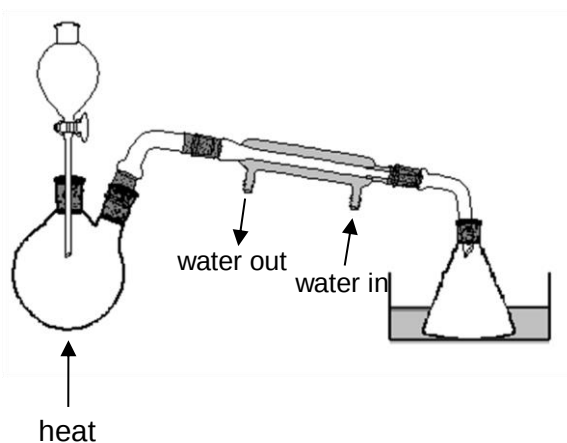


Limonene

When limonene reacts with excess bromine at room temperature in the dark, how many **more** chiral centers than limonene does the product molecule have?

- A 2 B 3 C 4 D 5

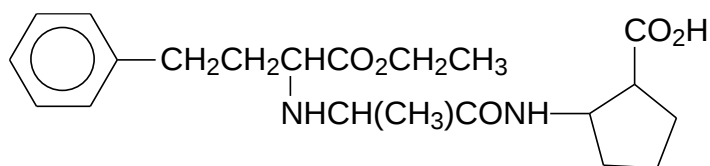
- 24 The diagram below shows some laboratory apparatus.



Which preparations could this apparatus be used for?

- A 1,2-dibromoethane from ethene and bromine
B ethanal from ethanol, sodium dichromate(VI) and sulfuric acid
C propanone from propan-1-ol, sodium manganate(VII) and sulfuric acid
D butan-2-ol from butanone, lithium aluminum hydride in dry ether

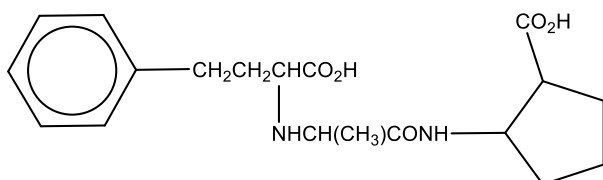
- 25 A prodrug is a molecule that can be converted into its active form in the body. An example is *Enalapril*, as shown below. The active form of *Enalapril* can be formed when enzymes in the body hydrolyse the esters found on the molecule.



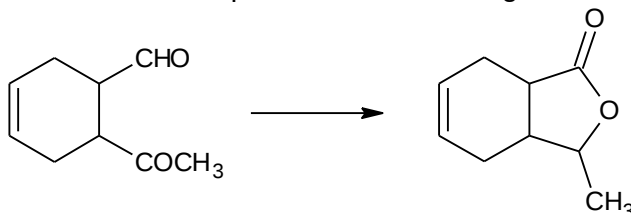
Enalapril

Which of the following is **not** true about *Enalapril*?

- A** *Enalapril* turns orange aqueous $K_2Cr_2O_7$ green when heated in an acidic medium.
B *Enalapril* does not react with 2,4-dinitrophenylhydrazine.
C *Enalapril* reacts with two moles ethanoyl chloride.
D The active form of *Enalapril* has the structure



- 26 Compound **V** can be converted to compound **W** in three stages.



Compound **V**

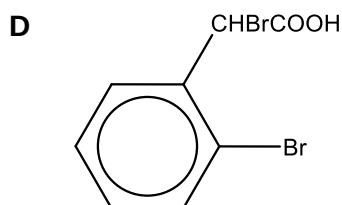
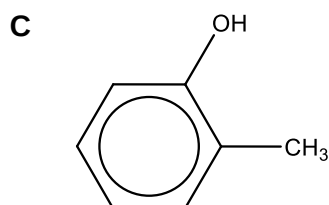
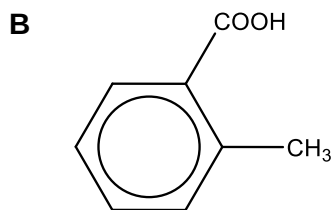
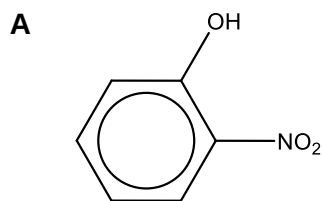
Compound **W**

Which sequence of reagents and conditions can be used to carry out this conversion?

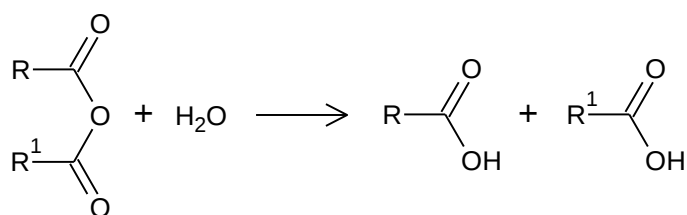
	Stage 1	Stage 2	Stage 3
A	hot acidified $KMnO_4$	H_2 with Pt catalyst	heat with dilute H_2SO_4
B	hot acidified $K_2Cr_2O_7$	$NaBH_4$ in ethanol	heat with dilute H_2SO_4
C	hot Fehling's reagent, followed by acidification	$NaBH_4$ in ethanol	heat with a few drops of conc. H_2SO_4
D	hot Tollens' reagent, followed by acidification	$LiAlH_4$ in dry ether	heat with a few drops of conc. H_2SO_4

27 Phenol has a pK_a of 10.0.

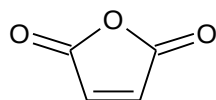
Which one of the following has a higher pK_a value than phenol?



28 An acid anhydride is a carboxylic acid derivative that undergoes hydrolysis in water similar to acyl chlorides and esters. A mixture of carboxylic acids is produced in the case of the anhydride.



Based on the information above, which of the following can be deduced when maleic anhydride undergoes hydrolysis in the presence of water labelled with the ^{18}O isotope?



maleic anhydride

- A** The resulting product is non-planar.
- B** The product is labelled with the ^{18}O isotope.
- C** Two carboxylic acid molecules are produced for every molecule of maleic anhydride.
- D** The reaction is faster than when maleic anhydride undergoes hydrolysis in the presence of water labelled with the ^{16}O isotope.

29 Which of the following reactions will **not** form a racemic mixture of products?

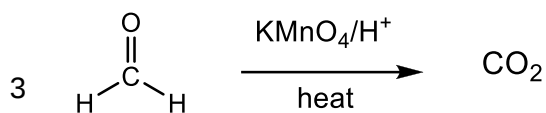
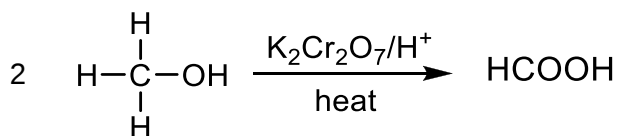
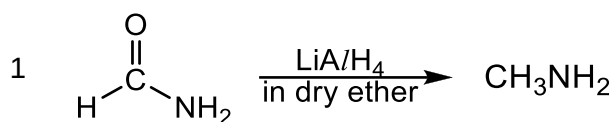
A CH_3COCH_3 with HCN in trace amounts of NaOH

B $\text{CH}_3\text{CH}_2\text{CH}_2\text{COCH}_3$ with HCN in trace amounts of NaCN

C
$$\begin{array}{c} \text{CH}_3 \\ | \\ \text{CH}_3\text{CH}_2\text{CH}_2-\text{C}-\text{Cl} \\ | \\ \text{CH}_3\text{CH}_2 \end{array}$$
 with KOH(aq), heat under reflux

D
$$\begin{array}{c} \text{CH}_3 \quad \text{H} \\ | \quad | \\ \text{CH}_3\text{CH}_2\text{CH}_2-\text{C}=\text{C}-\text{CH}_3 \end{array}$$
 with HBr(g)

30 In which reaction will the oxidation number of carbon change by 4?



A 1, 2 and 3

B 2 only

C 1 and 3 only

D 1 only

End of Paper