ST ANDREW'S JUNIOR COLLEGE

JC2 Preliminary Examinations

Chemistry Higher 2 **9647/01**

Paper 1 Multiple Choice **19 September 2013**

1 hour

Additional Materials: Multiple Choice Answer Sheet, Data Booklet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil. Do not use staples, paper clips, highlighters, glue or correction fluid.

There are **40** questions on this paper. Answer all questions. For each question there are four possible answers A, B, C and D. Chose 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.

This document consists of **19** printed pages **including** this page.

Section A

For each question there are four possible answers, **A**, **B**, **C** and **D**. Choose the one you consider to be correct.

1 The metal, **M** (A_r = 52.8), combines with 1.2 g of oxygen to form the oxide $\mathbf{M}_2O$. The metal, **M**, also forms a second oxide in which the metal and oxygen are present in the ratio 14:1 by mass.

What is the molecular formula of the second oxide?

A M_2O_3 **B** M_4O

C $M_{11}O_3$ **D** M_7O

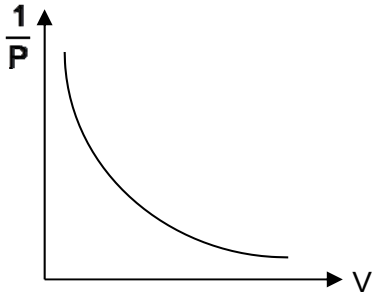
2 0.0100 mol of an oxide of an element, **L**, represented by $\mathbf{L}_2O_n$ is found to react with exactly 8.00×10^{-3} mol of acidified $KMnO_4$ solution. In the reaction, aqueous $H\mathbf{L}O_4^{2-}$ ion is formed. What is the initial oxidation state of **L**?

A + 1 **B** + 2

C + 3 **D** + 4

3 Which of the following diagrams correctly describes the behavior of a fixed mass of an ideal gas at constant *T*? (*T* is measured in K.)

A



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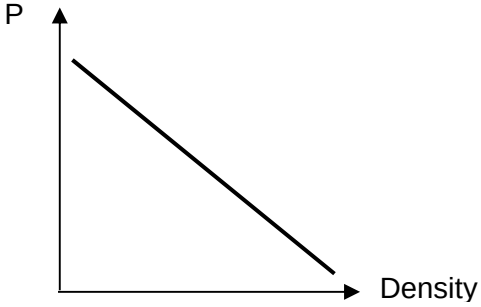

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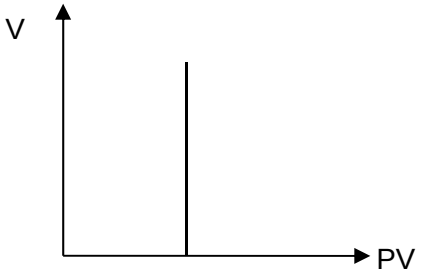
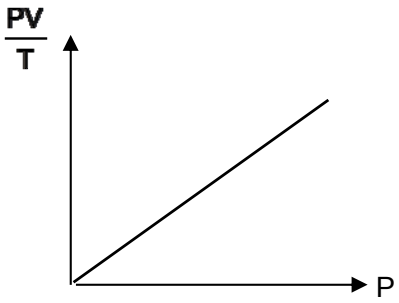


D



4 With reference to its electronic configuration, which of the following statements is true about the electrons in the atoms of the element with atomic number 29?

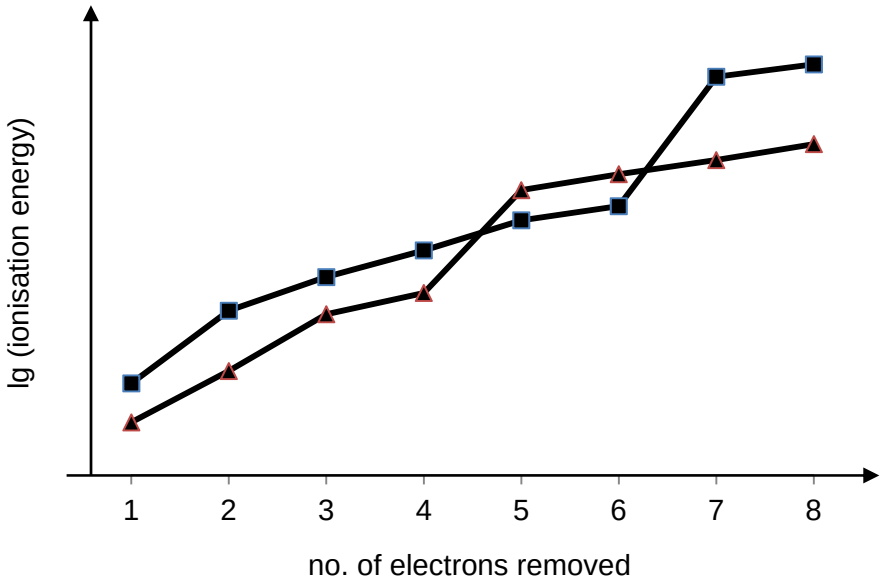
A The electrons in the outermost principle quantum shell experience inter-electronic repulsion.

B The d electrons are in the same principle quantum shell as the outermost s electrons.

C There are p electrons in 2 different principle quantum shells.

D There are s electrons in 3 different principle quantum shells.

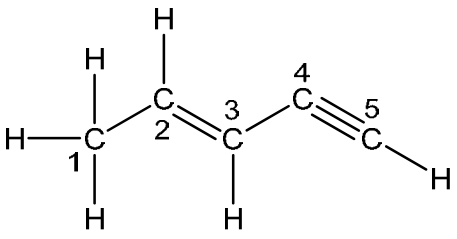
5 The graph shows the logarithm, lg, of the first eight ionisation energies of two elements in Periods 2 and 3.



What is the most likely compound that will be formed between the two elements?

A CO_2 **B** SiO_2 **C** CS_2 **D** $SiCl_4$

6 Covalent bonds are formed by orbital overlap. Which of the following is not present in the following molecule?



A sp^3-sp^2 overlap between C1 and C2

B sp^2-sp^2 overlap between C2 and C3

C sp^3-sp overlap between C3 and C4

D sp-sp overlap between C4 and C5

7 Which of the following molecules is planar?

A Benzene **B** SCl_6

C Butanone **D** Cyclohexene

8 Given the following enthalpy changes:

Enthalpy change of atomisation of carbon	= +715 kJ mol^{-1}
Enthalpy change of atomisation of oxygen	= +248 kJ mol^{-1}
Enthalpy change of combustion of carbon	= -394 kJ mol^{-1}

What is the bond energy of the C=O bond?

A 617 kJ mol^{-1} **B** 679 kJ mol^{-1}

C 740 kJ mol^{-1} **D** 803 kJ mol^{-1}

9 The enthalpy changes of formation of gaseous oxides of nitrogen are positive. Which of the following statements accounts for the positive enthalpy changes?

A Oxygen has a high tendency to form O^{2-} ions.

B Oxygen and nitrogen have similar electronegativity.

C Nitrogen has high ionisation energies.

D The nitrogen molecule has a high bond energy.

10 The equation below represents a monomer-dimer system:

$$2NO_2\ (g) \underset{k_b}{\overset{k_f}{\rightleftharpoons}} N_2O_4\ (g) \qquad \Delta H < 0$$

brown colourless

Which statement about the equilibrium is correct?

A k_f increases and k_b decreases when the equilibrium mixture is heated.

B Increasing the temperature decreases the equilibrium constant K_c.

C Addition of argon at constant volume shifts the equilibrium position to the right.

D Addition of a catalyst will increase the colour intensity of the mixture.

11 A 1:3 molar mixture of X_2 and Y_2 is heated at 673 K and 100 atm of constant pressure so that it comes to equilibrium. The equilibrium mixture contains 20 % of XY_3.

$$X_2(g) + 3Y_2(g) \rightleftharpoons 2XY_3(g)$$

Using the equation above, what is the numerical value of K_p for the reaction at 673 K?

A 9.26×10^{-5}

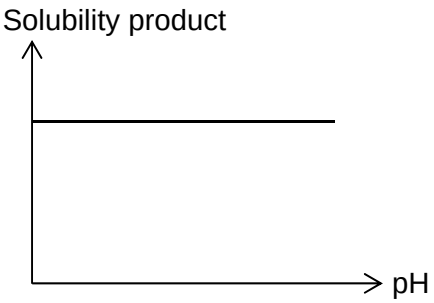
B 2.93×10^{-4}

C 2.50×10^{-4}

D 5.68×10^{-4}

12 The numerical value of the solubility product of copper (I) iodide is 1.27×10^{-12}. Given that HI is a strong acid, which diagram shows how the solubility product of CuI will vary with pH at constant temperature?

A



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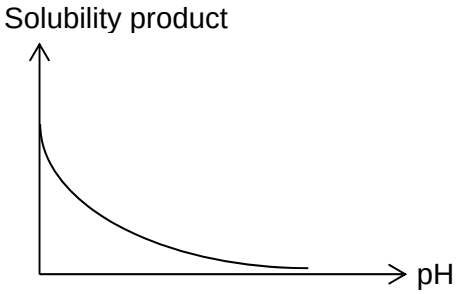
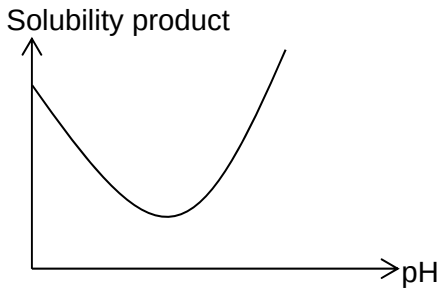
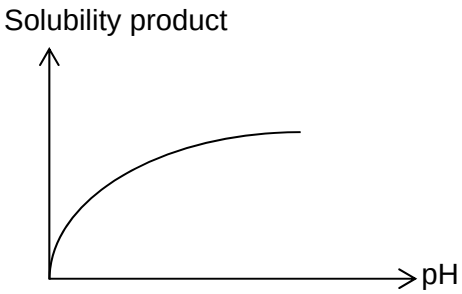


B



D



13 At 298 K, the numerical values for the dissociation constant of the aliphatic carboxylic acids, **R**CO_2H and **R'**CO_2H in aqueous solution are 4.8 x 10^{-6} and 3.6 x 10^{-3} respectively. Which of the following statements is true?

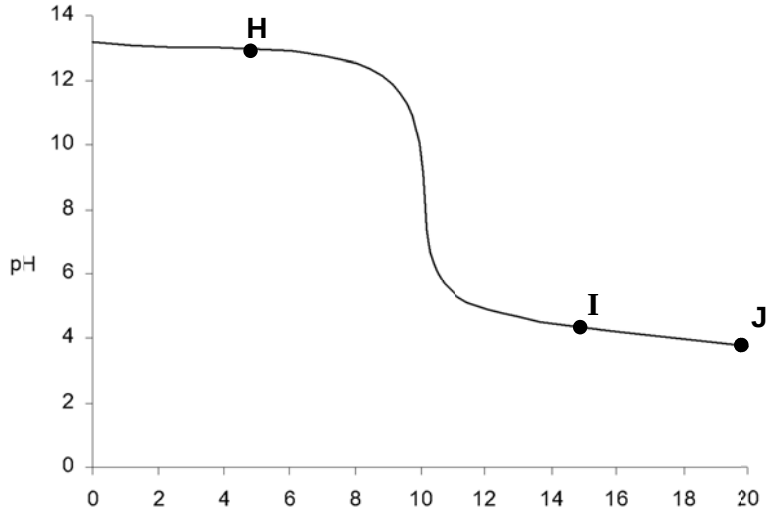
A **R**CO_2^- is a weaker base than **R'**CO_2^-.

B The volume of 1.0 mol dm^{-3} H_2SO_4 used to neutralize **R**$CO_2^-Na^+$ completely is lower than that for **R'**$CO_2^-Na^+$.

C A buffer solution is formed when 20 cm^3 of 0.01 mol dm^{-3} KO**H** is mixed with 10 cm^3 of 0.1 mol dm^{-3} **R**COOH.

D 0.10 mol dm^{-3} of **R'**COOH has a higher pH than 0.10 mol dm^{-3} of aqueous **R'**$CO_2^-Na^+$.

14 The graph shows the change in pH when 0.10 mol dm^{-3} acid is gradually added to 10 cm^3 of 0.1 mol dm^{-3} sodium hydroxide.



Which of the following correctly identifies the acid used and the point on the curve at which maximum buffer capacity occurs?

	Acid used	Maximum buffer capacity
A	HCN	**I**
B	H_2SO_4	**H**
C	HF	**J**
D	$(COOH)_2$	**I**

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

An electrochemical cell is set up using a $Fe^{3+}(aq)$, $Fe^{2+}(aq)$ half–cell and a $VO^{2+}(aq)$, $V^{3+}(aq)$ half–cell.

Which of the following gives a correct effect on the $E^{\ominus}_{cell}$ when each of the changes is made?

	Change	Effect on $E^{\ominus}_{cell}$
A	Doubles the concentration of Fe^{3+}	$E^{\ominus}_{cell}$ doubles
B	Addition of KCN(aq) to the $Fe^{3+}(aq)$, $Fe^{2+}(aq)$ half–cell	$E^{\ominus}_{cell}$ becomes more positive
C	Addition of water to the $VO^{2+}(aq)$, $V^{3+}(aq)$ half–cell	$E^{\ominus}_{cell}$ becomes more positive
D	Addition of NaOH to the $VO^{2+}(aq)$, $V^{3+}(aq)$ half–cell	$E^{\ominus}_{cell}$ becomes less positive

16 Two separate electrolyses were performed as follows, under standard conditions.

1) When concentrated hydrochloric acid was electrolysed for 10 minutes, 150 cm^3 of gas were collected from the anode.
2) When aqueous copper sulfate was electrolysed for 10 minutes, **x** cm^3 of gas were collected from the anode.

If the current used in electrolysis 1 was twice the current used in electrolysis 2, what is the volume of gas that were collected in electrolysis 2?

A 37.5 cm^3

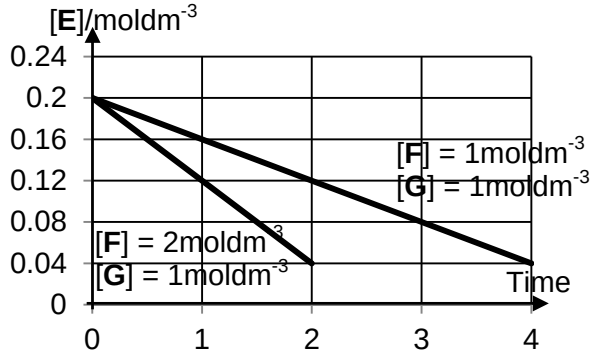
B 50 cm^3

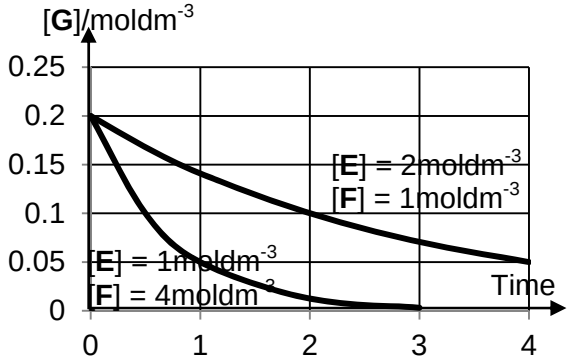
C 75 cm^3

D 125 cm^3

17 **E, F** and **G** react according to the following equation: **E**(aq) + 2**F**(aq) + **G**(aq) ⟶ products

Two sets of separate experiments are performed in order to determine the rate equation. The results are shown:





Which of the following statements is **not** true?

A For this reaction, the rate equation is based on the overall equation.

B The order of reaction with respect to [**E**] is zero.

C The order of reaction with respect to [**F**] is one.

D The order of reaction with respect to [**G**] is one.

18 Which of the following statements about the Period 3 elements is true across the period?

A The melting points of the elements decrease steadily.

B The electrical conductivity of the elements decreases steadily.

C The pH of the oxides in water decreases steadily.

D The solubility of the oxides in water increases steadily.

19 In which of the following reactions is chlorine gas formed?

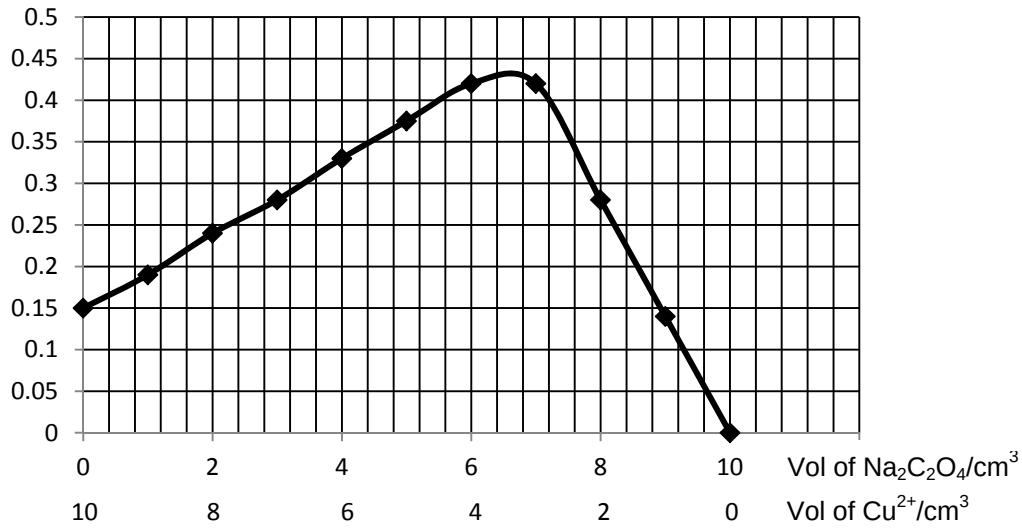
A NaC*l* is heated strongly with iodine.

B NaC*l* is heated with concentrated sulfuric acid.

C HC*l* is heated with concentrated sulfuric acid and manganese (IV) oxide.

D KC*l* is heated with aqueous iron (III) sulfate.

20 The stoichiometry of a complex can be determined by measuring the colour intensities of solutions containing different proportions of the ligand and metal ion. The following graph was obtained when different amounts of 1.0×10^{-4} mol dm^{-3} $Cu^{2+}(aq)$ and 1.0×10^{-4} mol dm^{-3} sodium ethanedioate solution were mixed.



Which of the following is the correct formula for the complex?

A $[Cu_2(C_2O_4)_3]^{2-}$ **B** $[Cu_3(C_2O_4)_2]^{2+}$

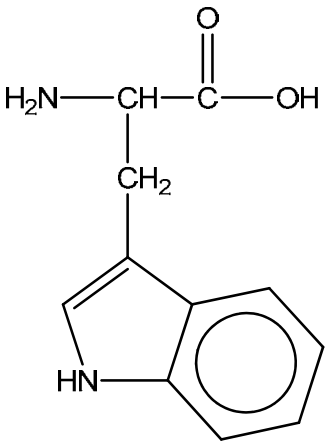
C $[Cu(C_2O_4)_3]^{4-}$ **D** $[Cu(C_2O_4)_2]^{2-}$

21 How many structural isomers are there for C_3H_8O?

A 1 **B** 2

C 3 **D** 4

22 Tryptophan is an amino acid and is essential to the human diet. It also serves as a biological precursor to some chemicals associated with the nervous system of the human body. It has an isoelectric point of 5.89.



What of the following statements is **not** true about tryptophan?

A It undergoes an electrophilic substitution reaction with Br_2 (aq).

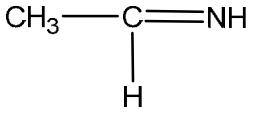
B It is chiral.

C It reacts with 3 moles of ethanoyl chloride.

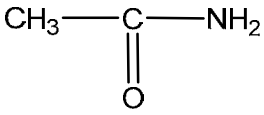
D It has a positive charge when placed in a solution at pH 3.

23 1-chloroethylamine reacts with aqueous sodium hydroxide under heat. The product then undergoes a rapid dehydration to form **K**. **K** does not react with bromine in tetrachloromethane. What is the likely structure of **K**?

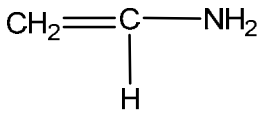
A



B



C



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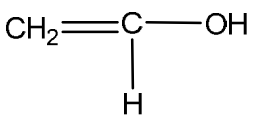
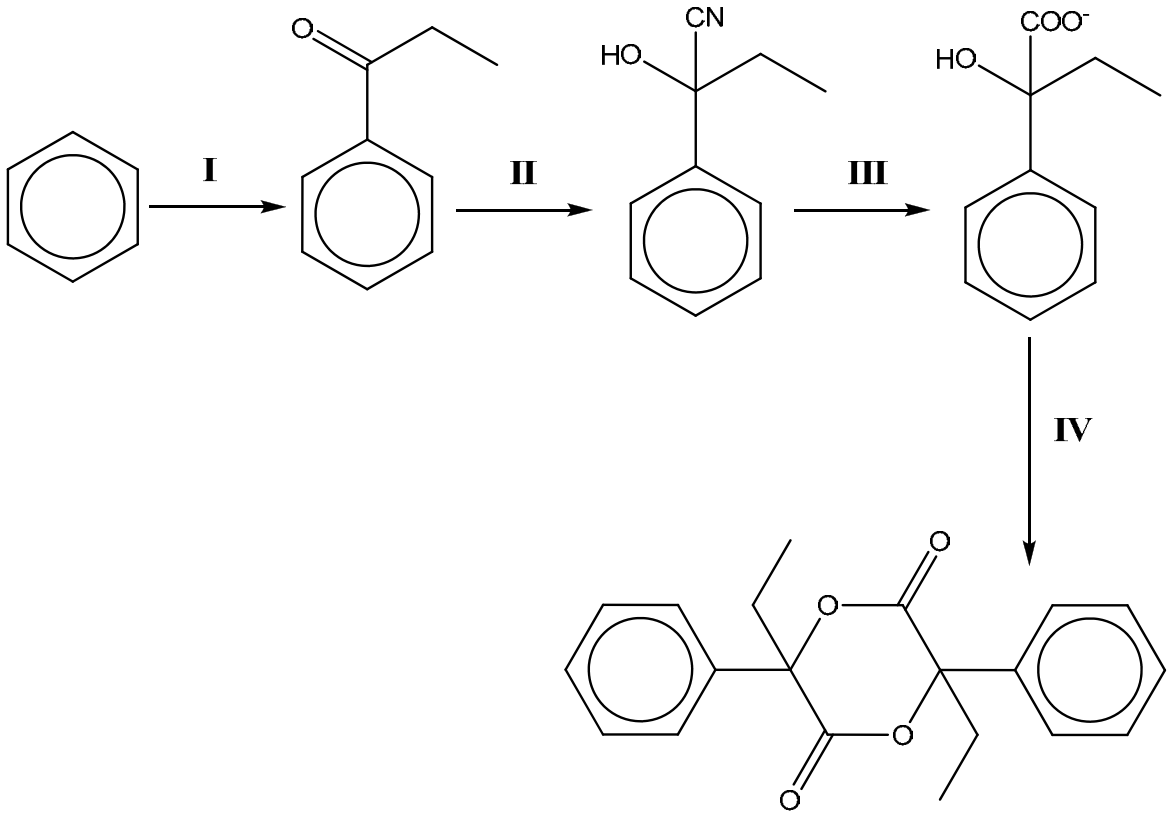


24 For the following conversion sequence, which of the steps stated will not result in a good yield?



A Step **I** - Propanoyl chloride with aqueous iron (III) chloride

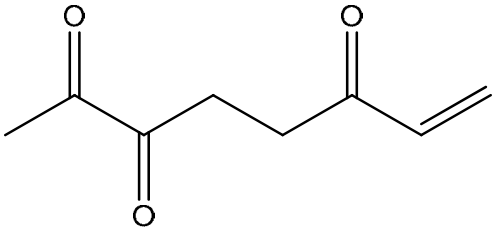
B Step **II** - Hydrogen cyanide with trace potassium cyanide at 15^0C

C Step **III** - Dilute aqueous sodium hydroxide with heat

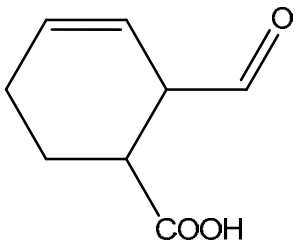
D Step **IV** - Concentrated sulfuric acid with heat

25 Compound **L** has the molecular formula $C_8H_{10}O_3$. It reacts with 2 moles of hydrogen gas in the presence of a platinum catalyst to form a compound with the formula $C_8H_{14}O_3$.
Which of the following could be **L**?

A



B



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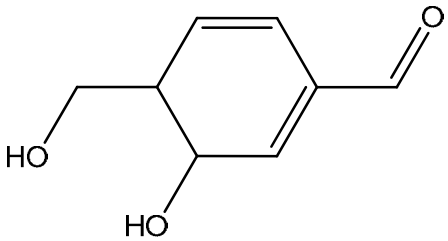

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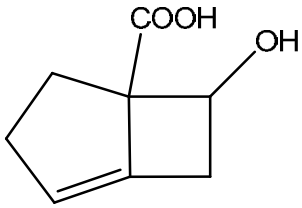
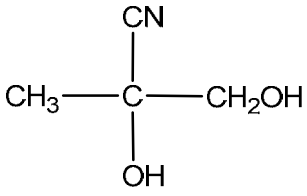
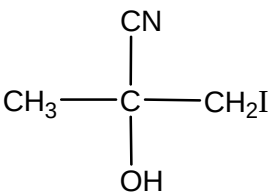


26 Which of the following are **not** possible products when 1-iodopropanone reacts with an equimolar mixture of hydrogen cyanide and sodium hydroxide in ethanol?

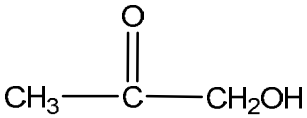
A



B



C



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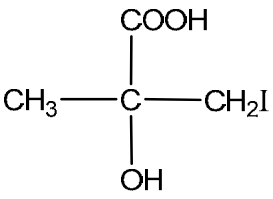
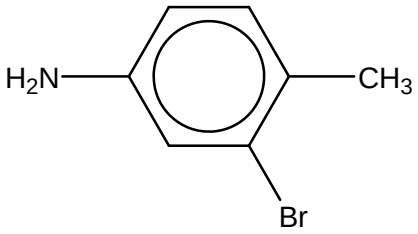


27 Which synthetic route is most likely to lead to the most successful synthesis of the following product from benzene?



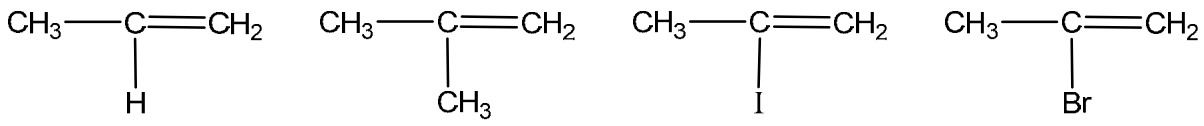
A Nitration, bromination, alkylation, reduction

B Nitration, bromination, reduction, alkylation

C Nitration, alkylation, reduction, bromination

D Alkylation, bromination, nitration, reduction

28 A comparison is made of the rate of electrophilic addition of Br_2 in CCl_4 to the following compounds:

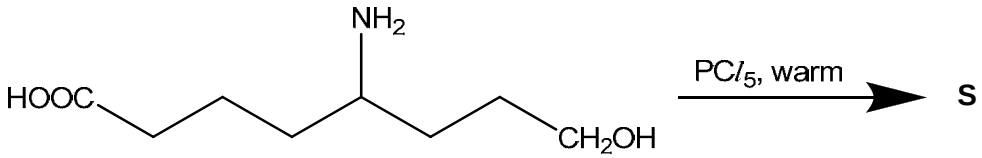


O **P** **Q** **R**

How will the reaction rates for each compound vary?

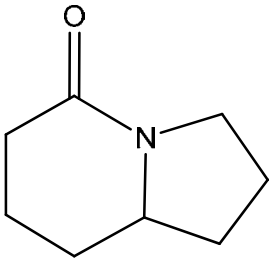
	Fastest → Slowest			
A	**P**	**O**	**Q**	**R**
B	**Q**	**R**	**O**	**P**
C	**P**	**O**	**R**	**Q**
D	**O**	**P**	**R**	**Q**

29 In the following reaction, one of the products is a solid compound **S**, which is insoluble in water.

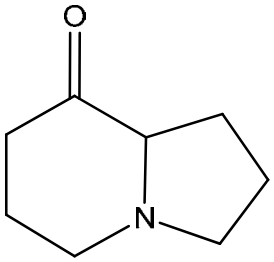


What is **S**?

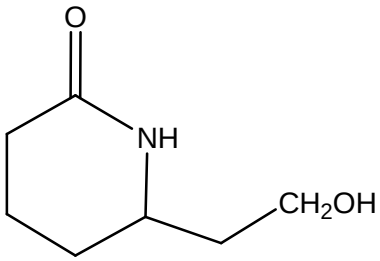
A



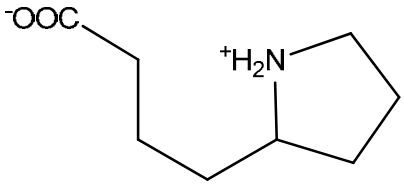
B



C



D



30 Century eggs are a traditional Chinese food product. They are made by coating eggs in a mixture of clay, salt (NaC*l*), and quicklime (CaO). This curing process usually takes about a month.

Through the curing process, the yolk becomes a dark green colour, while the egg white becomes a dark brown, translucent jelly.

Which of the following is true about the curing process?

A The presence of salt disrupts the van der Waals' forces in the egg protein.

B Mechanical agitation disrupts the hydrogen bonds in the egg protein.

C The increase in pH disrupts the ionic interactions in the egg protein.

D Quicklime reduces the disulfide bridges in the egg protein.

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 1 dm^3 of gas $\mathbf{X_2}$ and 1 dm^3 gas $\mathbf{Y_2}$ weighs 2 g and 6 g respectively under the same conditions of temperature and pressure.

Which of the following statements are correct?

1 The average velocity of the molecules in gas **X** is higher than that of gas **Y** at the same temperature.

2 The ratio of the M_r of **X** to **Y** is 3:1.

3 $\mathbf{Y_2}$ behaves more ideally than $\mathbf{X_2}$ under the same conditions of temperature and pressure.

32 In which pairs of species are the bond angle in **I** bigger than that in **II**?

	I	**II**
1	NCl_3	PCl_3
2	ICl_2^-	I_3^-
3	NO_3^-	NO_2^+

33 The solubilities of Group II metal sulfates decrease down the group. Which of the following explanations are correct?

1 The hydration energy of the cations becomes less exothermic down the group.

2 The variation in lattice energy is larger than the enthalpy change of hydration down the group.

3 The sulfate ion can be easily polarised.

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.

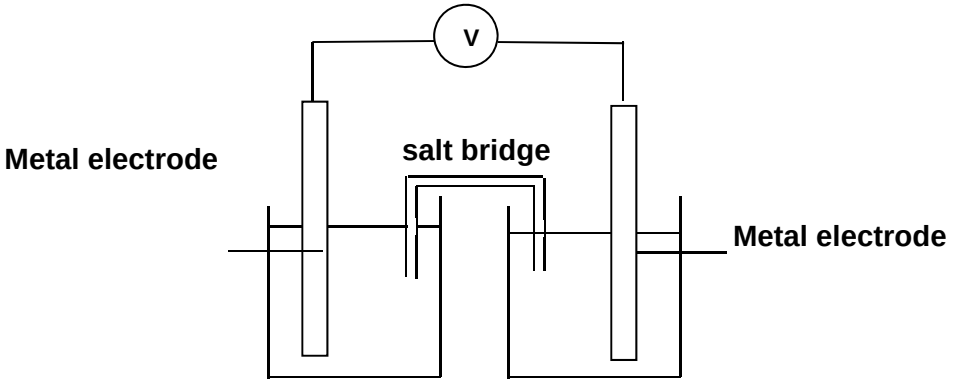
34 For which equilibrium does the value of $K_c = K_p$?

1 $H_2(g) + I_2(g) \rightleftharpoons 2HI_2(g)$

2 $C(s) + H_2O(g) \rightleftharpoons CO(g) + H_2(g)$

3 $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$

35 Four metals **W**, **X**, **Y** and **Z**, were connected in pairs as shown in the diagram below and the voltage was recorded.



The results obtained are recorded in the table below.

Cell	Metals used	$E^{\ominus}_{cell}$ / V	Positive terminal
1	**W** and **X**	+1.10	**W**
2	**X** and **Y**	+1.46	**Y**
3	**X** and **Z**	+0.47	**X**

Which of the following statements are correct?

1 **Y** is the strongest oxidising agent.

2 $E^{\ominus}_{cell}$ for metals **W** and **Y** is +0.36 V

3 **W** can reduce all the cations of **Y**, **X** and **Z**.

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.

36 A yellow solution was formed when crystalline potassium chromate(VI) was dissolved in water. On addition of dilute sulfuric acid, the solution turned orange. Upon bubbling hydrogen sulfide through the orange solution, there was a colour change in the solution and yellow sulfur was formed.

Which of the following processes occur in the above experiment?

1 Ligand exchange

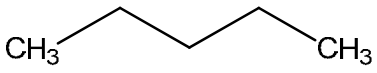
2 Redox reaction

3 Precipitation

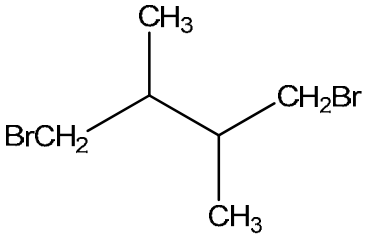
37 A compound **Z**, upon mono-chlorination with chlorine in the presence of UV light, forms 3 possible isomeric products.

Which of the following compounds could be **Z**?

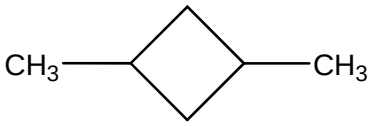
1



2



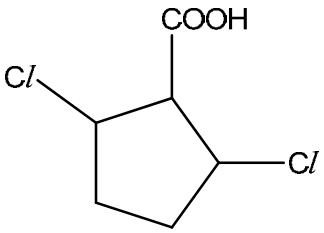
3



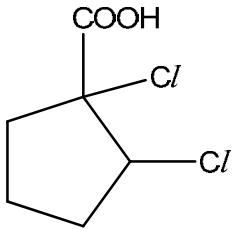
A	B	C	D
1, 2 and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is used as a correct response.

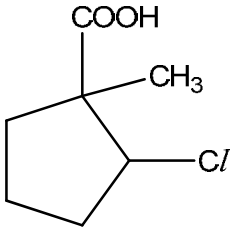
38 Which of the following is more acidic than the compound below?



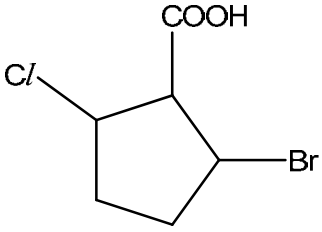
1



2



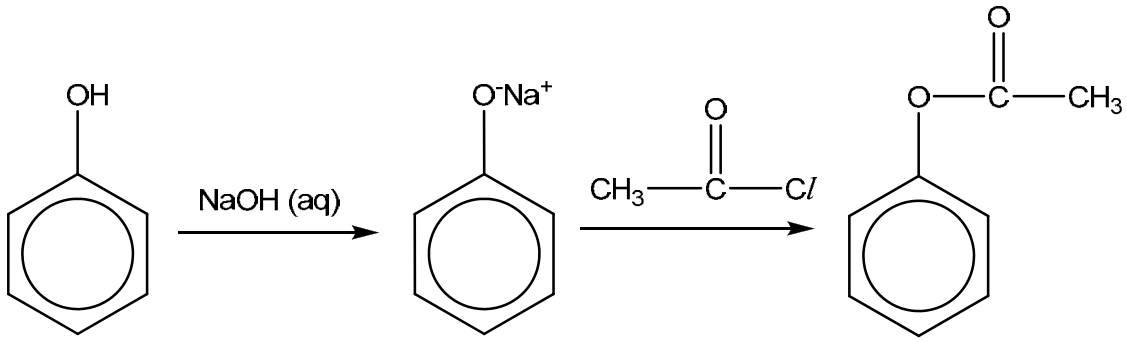
3



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.

39 For the following sequence of reactions, which are valid reasons for the choice of reagents used?

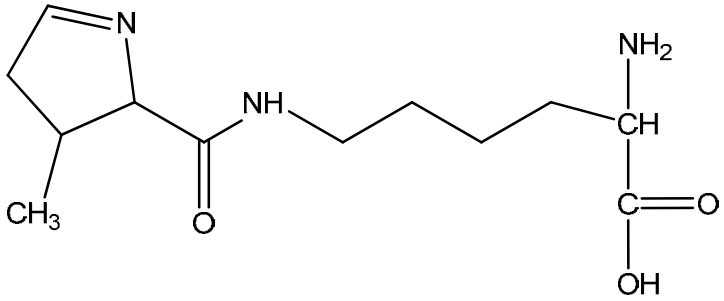


1 The formation of sodium phenoxide is necessary as it is soluble in water.

2 Phenoxide ion is a stronger nucleophile than phenol.

3 An acid chloride is used to improve the yield.

40 Pyrrolysine is a naturally occurring amino acid that appears in methane-producing bacteria.



Pyrrolysine

Which of the following statements are true of pyrrolysine?

1 It can be reduced by sodium borohydride.

2 It can form van der Waals interactions with proteins.

3 It undergoes condensation reaction with 2,4-dinitrophenylhydrazine.

~~~ END ~~~