

NANYANG JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 2

CHEMISTRY

Paper 1 Multiple Choice

9647/01

26 September 2014

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.

Write your name, class and tutor's name on the Answer Sheet in the spaces provided unless this has been done for you.

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.

This document consists of **22** printed pages and **0** blank page.

[Turn over

Section A

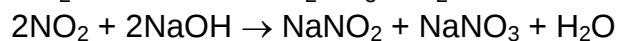
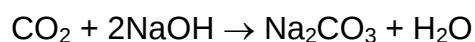
For each question there are four possible answers, **A**, **B**, **C** and **D**. Choose the **one** you consider to be correct.

- 1 0.02 mol of $C_xH_yNO_2$ was burned in excess of oxygen as shown by the equation below.



The gases that were produced were first passed through a U-tube containing phosphorus pentoxide and then bubbled through 0.25 mol of NaOH(aq).

The equations illustrating the reactions of the gases with NaOH(aq) are as shown below.



The phosphorus pentoxide U-tube increased in mass by 1.15 g and the excess NaOH required 40.00 cm³ of 0.875 mol dm⁻³ H₂SO₄ for complete reaction.

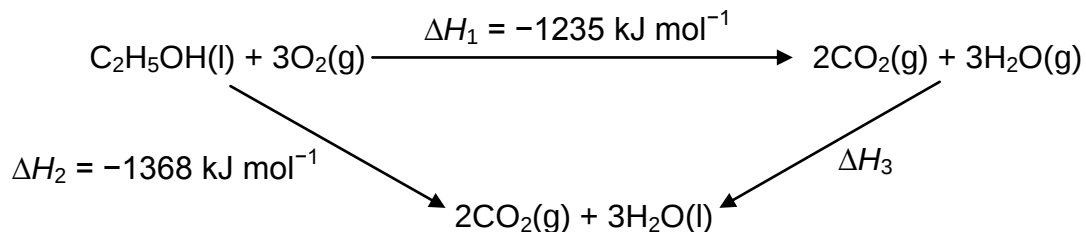
What is the ratio of x:y?

- A** 2:3
B 4:3
C 4:7
D 8:7
- 2 Which of these samples of gas contains half the number of atoms as 1 g of hydrogen (M_r : H₂, 2)?
- A** 22 g of carbon dioxide (M_r : CO₂, 44)
B 8 g of methane (M_r : CH₄, 16)
C 20 g of neon (M_r : Ne, 20)
D 8 g of ozone (M_r : O₃, 48)

- 3 Which transition metal ion in the following species has one more electron in the third quantum shell than in the second quantum shell?
- A $[\text{Cu}(\text{EDTA})]^{2-}$
B $[\text{Fe}(\text{H}_2\text{O})_5(\text{SCN})]^{2+}$
C $[\text{Ni}(\text{NH}_2\text{CH}_2\text{CH}_2\text{NH}_2)_3]^{2+}$
D $[\text{VO}(\text{C}_2\text{O}_4)_2(\text{H}_2\text{O})]^{2-}$
- 4 Which of the following statements about the properties associated with ionic and covalent bonds is correct?
- A The only covalent compounds with high melting points are those in which hydrogen bonds occur.
B Any covalent compound that contains both oxygen and hydrogen in its molecule forms hydrogen bonds.
C Ionic bonds and covalent bonds cannot both occur in the same compound.
D Ionic compounds differ from metals in that ionic compounds do not conduct electricity in the solid state.
- 5 For a fixed mass of an ideal gas, which of the following graphs does **not** have the same general shape as the graph of V/T against T plotted at constant P ?
(ρ = density of the gas)
- A p/ρ against V (at constant T)
B PV against ρ (at constant T)
C ρT against P (at constant T)
D ρT against V (at constant P)

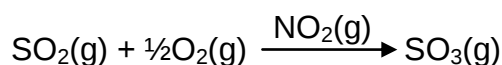
- 6 The standard enthalpy change of vapourisation, ΔH_{vap} , is defined as the enthalpy change when one mole of a substance changes from liquid state to the gaseous state under standard conditions.

Given the following energy cycle,

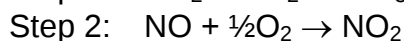
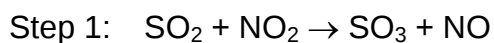


what is the entropy change when 108 g of water vapourises at 373 K?

- A -2139 J K^{-1}
 B -713 J K^{-1}
 C $+713 \text{ J K}^{-1}$
 D $+2139 \text{ J K}^{-1}$
- 7 Oxidation of atmospheric SO_2 can be catalysed by NO_2 as shown in the following equation.



The proposed mechanism for the oxidation process is as follows:



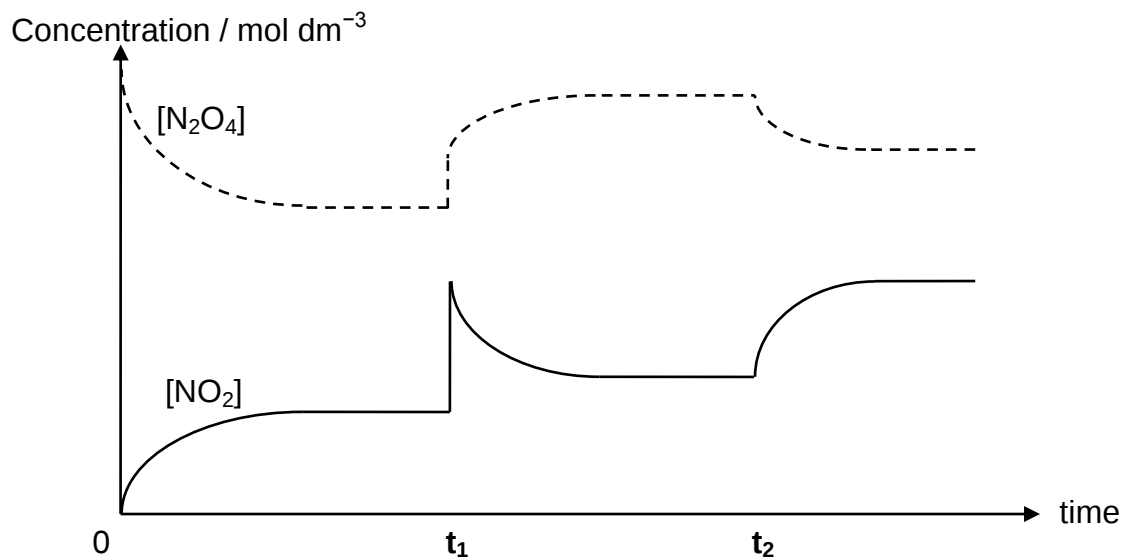
Which of the following statement is **not** correct?

- A Both SO_2 and SO_3 can cause acid rain.
 B NO_2 is a free radical.
 C NO is not a homogenous catalyst.
 D Nitrogen atom exhibits variable oxidation states in this reaction.

8 Consider the following equilibrium,



A certain amount of N_2O_4 was placed in a closed vessel and allowed to reach equilibrium.

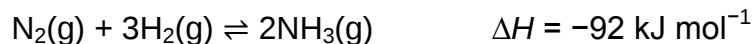


Two changes were made to the equilibrium system at t_1 and t_2 .

Using the graph above, what are the changes made at t_1 and t_2 ?

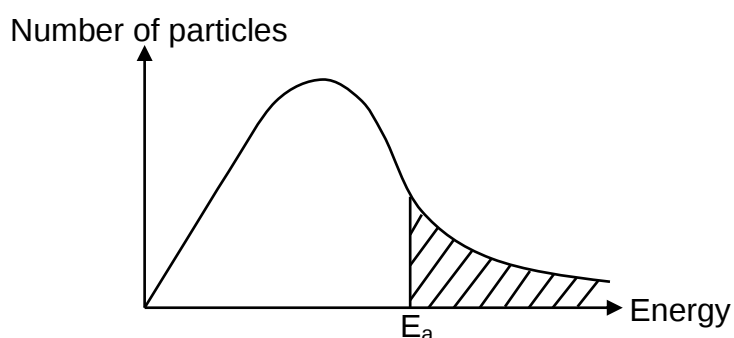
- | t_1 | t_2 |
|------------------------------------|-----------------------------------|
| A $[\text{NO}_2]$ increase | $[\text{N}_2\text{O}_4]$ decrease |
| B Pressure increase | $[\text{N}_2\text{O}_4]$ decrease |
| C Volume of vessel decrease | Temperature increase |
| D Catalyst added | Temperature increase |

- 9 The Haber process is an industrial reaction to produce ammonia from nitrogen and hydrogen.



Typical conditions used in the Haber process are 200 atm and 450 °C. When a mixture of 2.0 mol of nitrogen, 6.0 mol of hydrogen and 4.0 mol of ammonia is placed in a 2 dm³ closed vessel and allowed to reach equilibrium at 450 °C, half of the ammonia was decomposed.

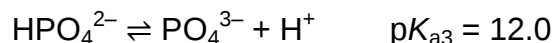
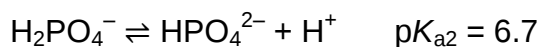
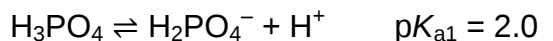
The Boltzmann distribution diagram of Haber process is shown below.



Which of the following statement is correct?

- A The K_c value is $7.32 \times 10^{-3} \text{ mol}^{-2} \text{ dm}^6$ at 500 °C.
- B The percentage yield of ammonia can be increased when ammonia is immediately removed once it is produced.
- C When a heterogeneous catalyst is added, the shaded area decreases.
- D When a heterogeneous catalyst is added, the position of equilibrium shifts to the right, producing more ammonia.

10 Phosphate buffers are commonly used in biological chemistry research.

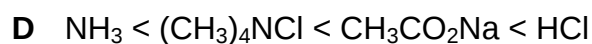
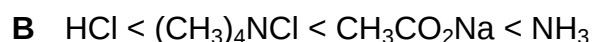


A phosphate buffer with pH 7.4 was prepared using NaH_2PO_4 and Na_2HPO_4 solutions. The total hydrogen phosphates concentration ($[\text{HPO}_4^{2-}] + [\text{H}_2\text{PO}_4^-]$) of the buffer was 0.3 mol dm^{-3} .

What are the concentrations of NaH_2PO_4 and Na_2HPO_4 used to create this buffer?

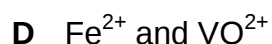
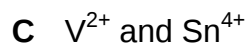
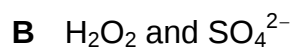
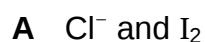
	$[\text{NaH}_2\text{PO}_4] / \text{mol dm}^{-3}$	$[\text{Na}_2\text{HPO}_4] / \text{mol dm}^{-3}$
A	0.23	0.07
B	0.07	0.23
C	0.10	0.50
D	0.05	0.25

11 Which of the following 0.10 mol dm^{-3} solutions are arranged in order of increasing pH?



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

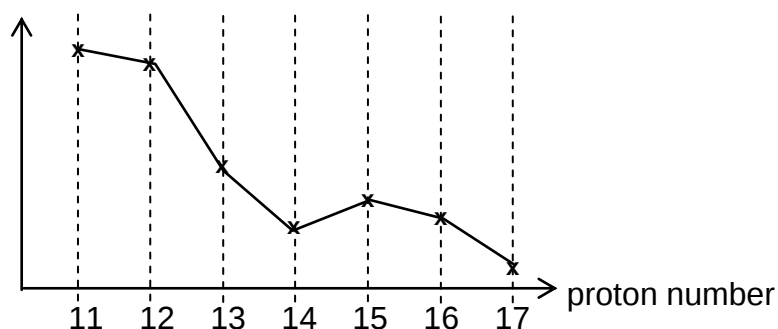
Which of the following pairs of reagents can have a feasible reaction?



- 13** A current of 0.44 A is passed through a solution of ruthenium nitrate causing reduction of the metal ion. After 25 minutes, 0.345 g of ruthenium has been deposited. What is the formula of ruthenium nitrate?

- A** RuNO_3
- B** $\text{Ru}(\text{NO}_3)_2$
- C** $\text{Ru}(\text{NO}_3)_4$
- D** $\text{Ru}(\text{NO}_3)_6$

- 14** The graph below shows how a property of the elements sodium to chlorine varies with proton number.



Which of the following best represents the property?

- A** atomic radius of their elements
 - B** first ionisation energy of their elements
 - C** melting points of their chlorides
 - D** melting points of their oxides
- 15** When 1.0 g of a Group II nitrate was heated at a certain temperature, the gases liberated at r.t.p. had a total volume of 0.4 dm^3 .

What is the identity of the group II nitrate?

- A** $\text{Mg}(\text{NO}_3)_2$
- B** $\text{Ca}(\text{NO}_3)_2$
- C** $\text{Sr}(\text{NO}_3)_2$
- D** $\text{Ba}(\text{NO}_3)_2$

16 Group VII elements and their compounds exhibit trends in properties.

Which of these properties increases down the group $\text{Cl} \rightarrow \text{Br} \rightarrow \text{I}$?

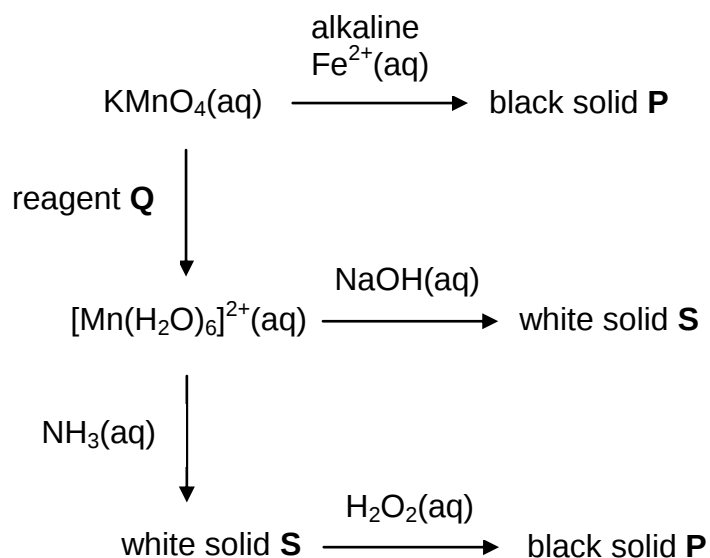
- A solubility of silver halides
- B oxidising power of the elements
- C acidity of hydrogen halides
- D electron affinity of the elements

17 Sodium chloride and sodium iodide is easily oxidised by concentrated sulfuric acid to produce a mixture of products.

Which of the following observations **cannot** be made from this reaction?

- A black solid
- B yellow solid
- C rotten egg smell
- D yellowish green fumes

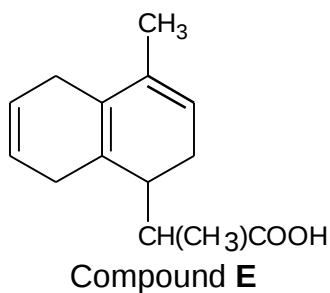
18 A reaction scheme regarding manganese compounds is shown below.



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

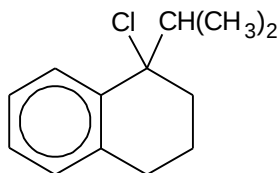
- A White solid **S** is able to dissolve in excess of $\text{NH}_3(\text{aq})$.
- B Manganese in black solid **P** has an oxidation state of +4.
- C Reagent **Q** can be acidified $[\text{V}(\text{H}_2\text{O})_6]^{3+}(\text{aq})$.
- D White solid **S** turns brown upon standing.

- 19 What is the total number of oxygen atoms present in all organic products when compound **E** is reacted with hot acidified KMnO_4 , followed by $\text{NaBH}_4(\text{aq})$?

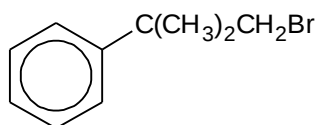


- A 7
B 8
C 10
D 11
- 20 When **F** reacts with ethanolic sodium hydroxide to form an organic product **G**. When **G** reacts with hot KMnO_4 , only one organic product was formed. Which of the following could be the identity of compound **F**?

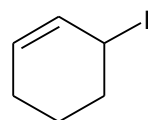
A



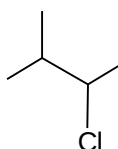
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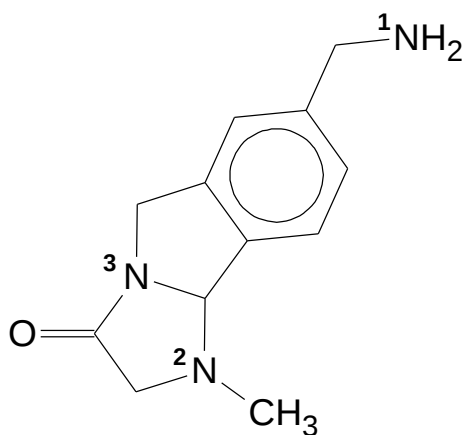
C



D



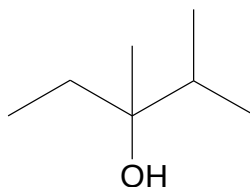
21 The following compound contains 3 nitrogen atoms, labelled 1, 2 and 3.



Which of the following correctly arranges the nitrogen atoms in terms of decreasing pK_b values?

- A 1, 2, 3
- B 3, 2, 1
- C 2, 3, 1
- D 1, 3, 2

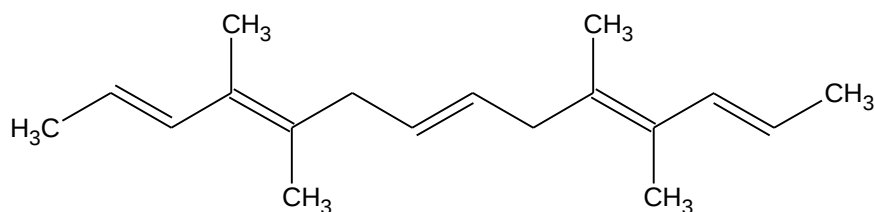
22 The structure of compound **Z** is as seen below:



It is completely reacted with hot concentrated H_2SO_4 to form compound **Y**. What is the total number of isomers of **Y**?

- A 2
- B 3
- C 4
- D 5

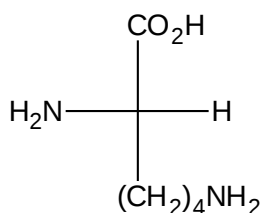
23 The following is the structure of molecule **Q**:



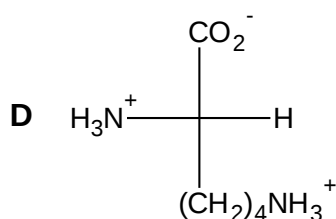
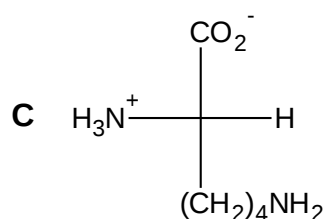
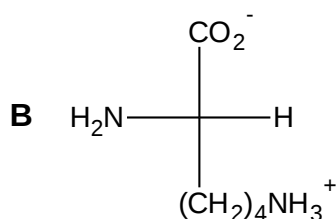
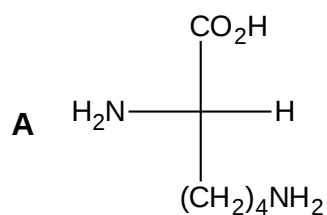
It can be reduced and hydrogenated to **R**. How many stereoisomers do the molecules of **Q** and **R** have?

	Q	R
A	4	8
B	8	8
C	16	16
D	32	16

24 Lysine is an essential amino acid found in the body. It has three pK_a values associated with it: 2.2, 9.0 and 10.5.



Which of the following structures represent the dominant form of lysine at pH 7.0?



- 25 Three unknown compounds, **X**, **Y** and **Z** were treated with hot ethanolic silver nitrate. The following results were obtained:

X	Y	Z
No ppt observed	White ppt formed after 10 minutes	Ppt formed immediately

Which of the following could be the identities of compounds **X**, **Y** and **Z**?

	X	Y	Z
A	CH_2FCH_3	$\text{C}_6\text{H}_5\text{CH}_2=\text{CHCl}$	CH_3COCl
B	$\text{C}_6\text{H}_5\text{Cl}$	$\text{CH}_3\text{CH}_2\text{I}$	CH_3COCl
C	$\text{CH}_2=\text{CHBr}$	$\text{CH}_3\text{CH}_2\text{Cl}$	$\text{CH}_3\text{CH}_2\text{I}$
D	$\text{CH}_3\text{CH}_2\text{Cl}$	$\text{CH}_3\text{CH}_2\text{Br}$	$\text{CH}_3\text{CH}_2\text{I}$

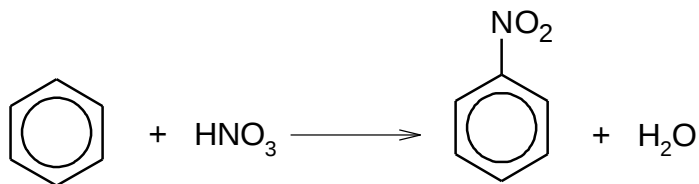
- 26 In the free radical substitution of 2-methylbutane with bromine, a mixture of mono-brominated compounds were obtained.

What is the statistical ratio of the two compounds with the highest yields?

- A** 1 : 1 **B** 1 : 2
C 1 : 3 **D** 1 : 6

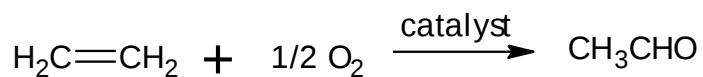
- 27 Nitrobenzene is a yellow liquid with the smell of almonds. It may be prepared by heating a mixture of benzene, concentrated nitric acid and concentrated sulfuric acid under reflux.

Why is concentrated sulfuric acid used?

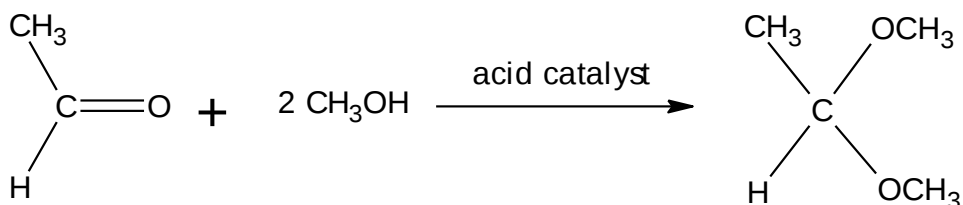


- A** It acts as a dehydrating agent to remove the water produced.
B It donates protons to nitric acid, thus forming NO_2^+ ions.
C It removes protons from nitric acid, thus forming NO_2^- ions.
D It acts as a catalyst to speed up the reaction.

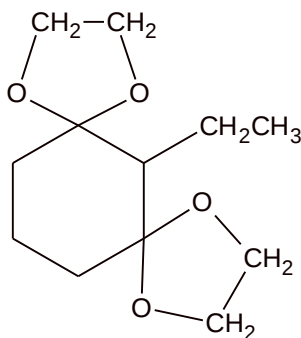
- 28 Alkenes undergo catalytic oxidation to produce aldehydes and ketones
e.g.



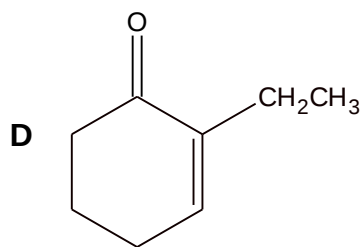
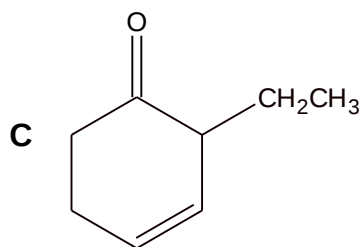
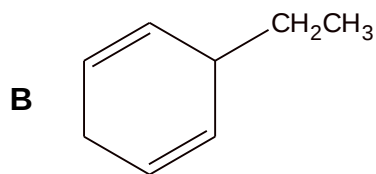
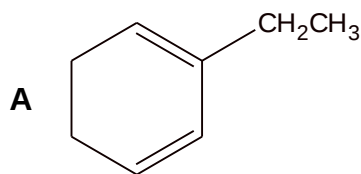
Acetals (molecules that contain 2 –OR groups bonded to the same carbon) can be formed from aldehydes and ketones in an acid catalysed process
e.g.



Compound **W** undergoes catalytic oxidation, followed by $\text{HOCH}_2\text{CH}_2\text{OH}$ in an acidic medium to produce the following as the only product.

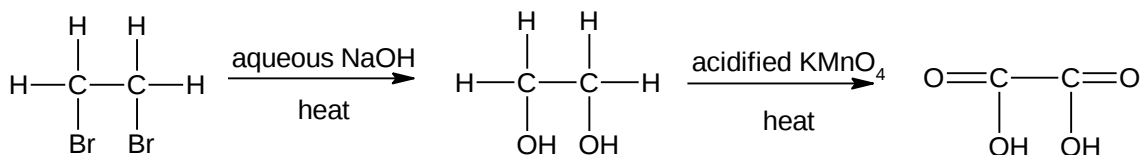


Which of the following best represents the structure of compound **W**?

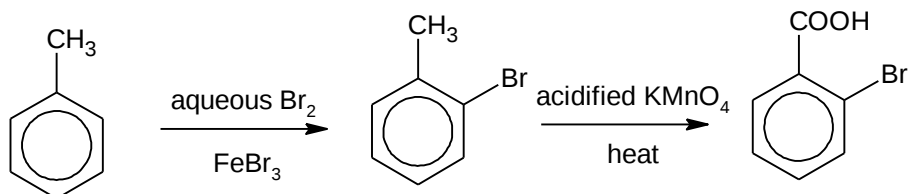


29 Which synthetic route is the most feasible?

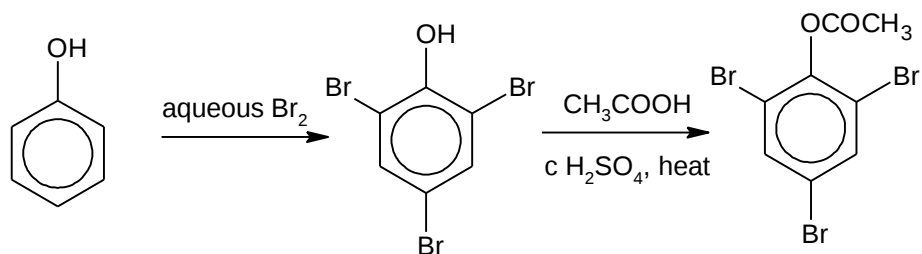
A



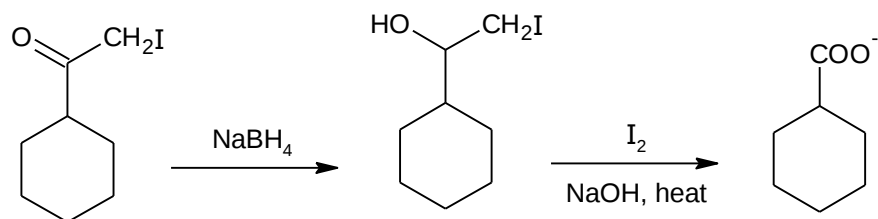
B



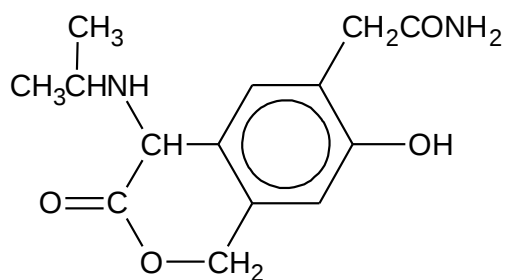
C



D



30



How many moles of cold aqueous hydrochloric acid are required to react with one mole of the above molecule?

A 1

B 2

C 3

D 4

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 which 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 J has the formula of $[\text{XeOF}_n]^{m+}$. It has a square-pyramidal shape.

Which of the following statements about **J** are correct?

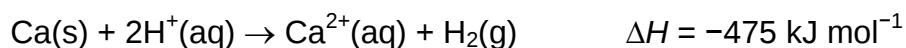
- 1** There are 12 electrons around the Xe atom.
- 2** The value of *m* is 0.
- 3** The value of *n* is 4.

The responses **A** to **D** should be selected on the basis of

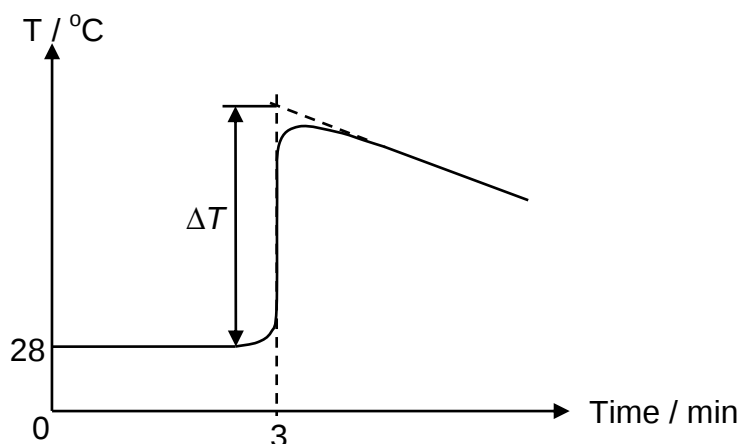
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

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

- 32** Student **P** carried out an experiment to verify the enthalpy change of reaction between calcium metal and acid.



He placed 140 cm^3 of 0.25 mol dm^{-3} HCl(aq) into a polystyrene cup and the temperature of the solution is recorded at 0.5 minute interval for 2.5 minutes. At exactly 3 minutes, he added 0.50 g of calcium metal into the solution and stirred. The temperature is recorded immediately and subsequently every 0.5 minutes for another 5 minutes. His results were plotted on the graph below.



Students **Q** also performed the same experiment using the same mass of calcium metal but uses 0.25 mol dm^{-3} $\text{CH}_3\text{COOH(aq)}$.

The volume of acid used by the two students is the same.

Assume that the densities of all solutions are 1.0 g cm^{-3} and 4.18 J of heat raise the temperature of 1 cm^3 of solution by 1°C .

Which statements are correct?

- 1 The highest temperature that student **P** can achieve is 38.1°C .
- 2 The highest temperature that student **Q** can achieve is lower than student **P**.
- 3 The extrapolation on the graph when determining ΔT is to account for the heat lost to the surrounding.

The responses **A** to **D** should be selected on the basis of

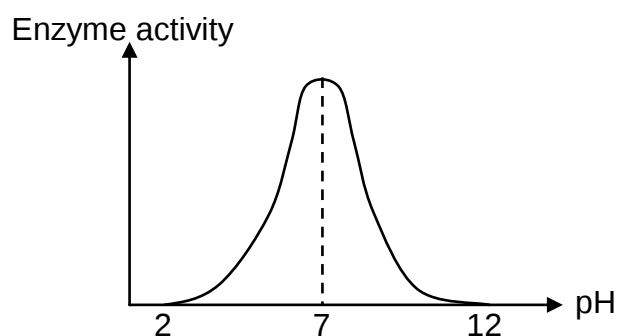
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

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

33 Decomposition of hydrogen peroxide can be catalysed by an enzyme, catalase.

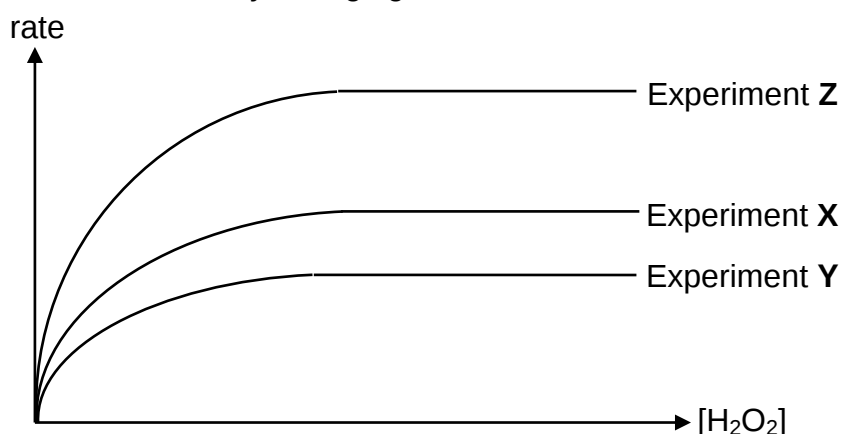


Enzymes are made of proteins and works most effectively at a particular pH, known as the optimum pH.



The optimum pH for catalase is pH 7. It is completely denatured under extreme low and high pH conditions.

A student performed experiment **X** to investigate the decomposition of H_2O_2 using catalase at pH 7. He also performed experiments **Y** and **Z** to further investigate the reaction by changing two other conditions.



Which statements are correct?

- 1** Experiment **Y** is carried out at pH 8.
- 2** Experiment **Z** is carried out with higher concentration of catalase.
- 3** The activation energy of experiment **Y** is the largest.

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.

34 The solubility products at 25 °C of some sulfates are shown below.

sulfates	$K_{sp} / \text{mol}^2 \text{dm}^{-6}$
barium sulfate	1.08×10^{-10}
calcium sulfate	4.93×10^{-5}
lead sulfate	2.53×10^{-8}

A 100 cm³ solution containing $1 \times 10^{-3} \text{ mol dm}^{-3}$ each of barium, calcium and lead ions was prepared. $1 \times 10^{-3} \text{ mol dm}^{-3}$ of sodium sulfate is then added dropwise.

Which of the following statements is true?

- 1 When 50 cm³ of sodium sulfate is added to the solution, the metal ions left in the solution are Na⁺ and Ca²⁺ ions.
- 2 Addition of hot sodium sulfate decreases the solubility products of all three sulfates.
- 3 After the precipitation of barium sulfate, the removal of the precipitate will increase the solubility of the other sulfates.

35 Which statements are true about the elements in Group II of the Periodic Table?

- 1 BeCl₂ has a higher boiling point than MgCl₂ as BeCl₂ has a more exothermic lattice energy than MgCl₂.
- 2 MgCO₃ is less thermally stable than CaCO₃ as Mg²⁺ has a greater polarising power than Ca²⁺ to distort the electron cloud of CO₃²⁻.
- 3 Mg reacts less vigorously with dilute acids than Ba as Mg has weaker reducing power than Ba.

The responses **A** to **D** should be selected on the basis of

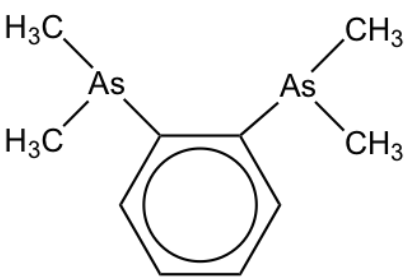
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

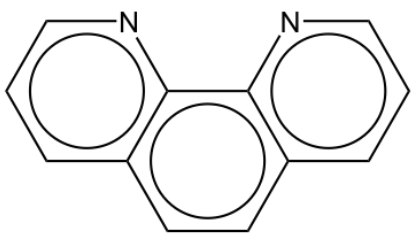
No other combination of statements is used as a correct response.

36 Transition metals are able to form metal complexes with chelating ligands.

Which of the following statements are correct?

1 $\text{PtCl}_2(\text{NH}_3)_2$ is a metal complex that has a coordination number of 4.

2  is a bidentate ligand.

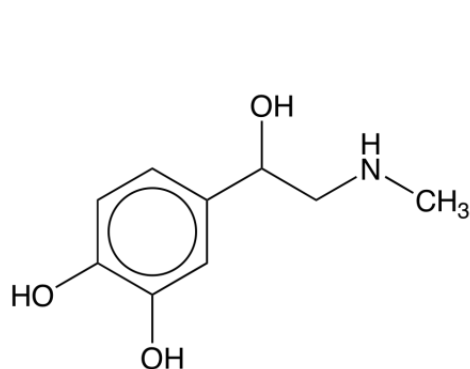
3  cannot act as a chelating ligand as the lone pairs of electrons on the nitrogen atoms are delocalised into the benzene ring.

The responses **A** to **D** should be selected on the basis of

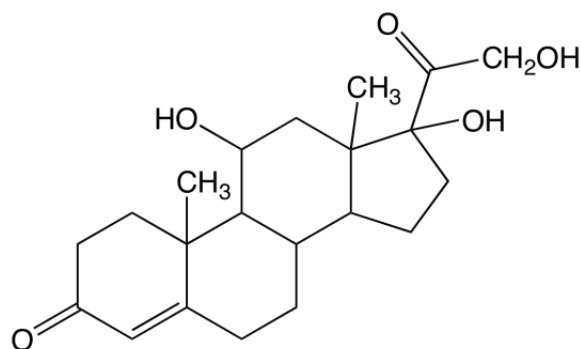
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

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

37 Adrenaline and hydrocortisone are hormones produced by the adrenal glands.



adrenaline

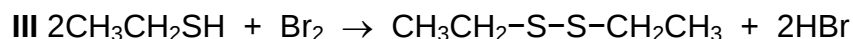
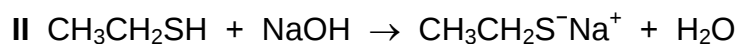
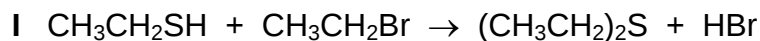


hydrocortisone

Which of the following reagents can be used to distinguish the two hormones?

- 1** Aqueous neutral FeCl_3
- 2** Hot aqueous potassium dichromate(VI)
- 3** Sodium metal

38 Thiols are organic compounds containing the $-\text{SH}$ functional group. They are sulfur analogue of alcohols. Some common reactions undergone by thiols are shown as follows.



Which of the following statements comparing thiols with alcohols are true?

- 1** Thiols are stronger nucleophiles than alcohols.
- 2** Thiols are stronger acids than alcohols.
- 3** Thiols are stronger reducing agents than alcohols.

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.

- 39** 1-Bromopropane may be prepared by slowly adding concentrated sulfuric acid to a mixture of propan-1-ol and sodium bromide, and keeping the reaction mixture cool.

What could be a by-product of this reaction if the temperature is allowed to rise?

- 1** Br₂
- 2** SO₂
- 3** CH₃CH=CH₂

- 40** Chlorofluorocarbons (CFCs) have been widely used in aerosol sprays, refrigerators and in making foamed plastics, but are now known to destroy ozone in the upper atmosphere.

Which of the following will **not** destroy ozone, and therefore can be used safely as a replacement for CFCs?

- 1** CH₃CH₂CH₂CH₃
- 2** Cl₃CBr₃
- 3** CHClFCClF₂