

NATIONAL JUNIOR COLLEGE
SH2 PRELIMINARY EXAM
 Higher 2

CANDIDATE
NAME

SUBJECT
CLASS

REGISTRATION
NUMBER

CHEMISTRY

Paper 1 Multiple Choice

Additional Materials:

Multiple Choice Answer Sheet

Data Booklet

9647/01

Thu 19 Sept 2013

1 hour

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

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

Write your name, subject class and registration number on the Answer Sheet in the spaces provided unless this has been done for you.

There are **40** 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 paper consists of **19** printed pages and **0** blank page.

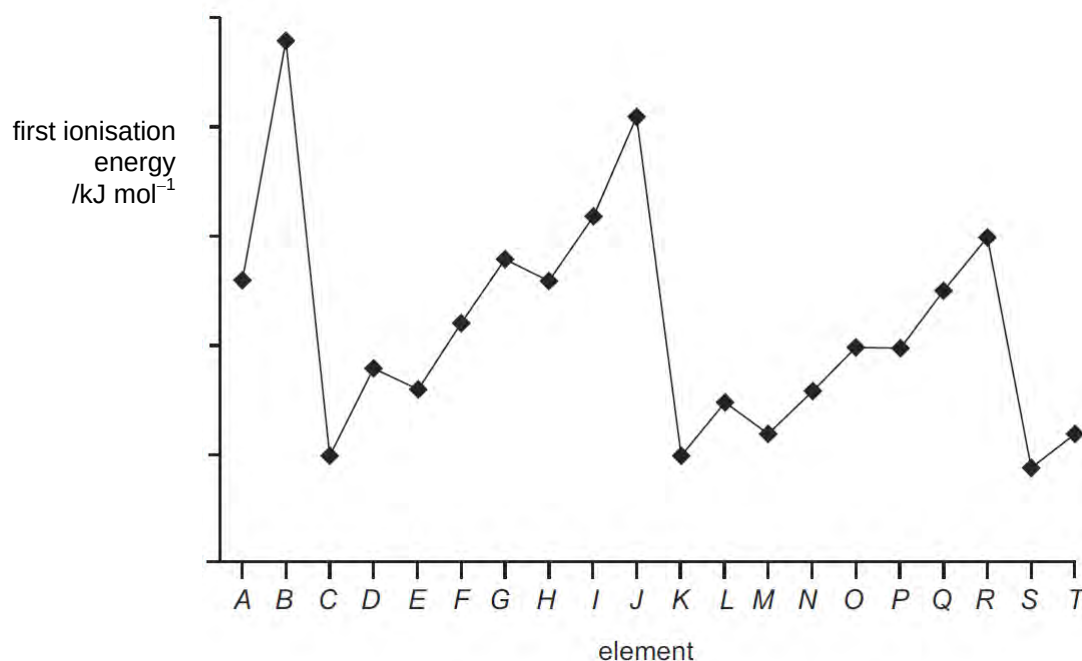
Section A

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

- 1 Which one of the following represents the configuration of the three electrons of highest energy for the ground state of an element in group III?

- A $1s^2 2s^1$
- B $1s^1 2s^1 2p^1$
- C $2s^1 2p^2$
- D $4s^2 4p^1$

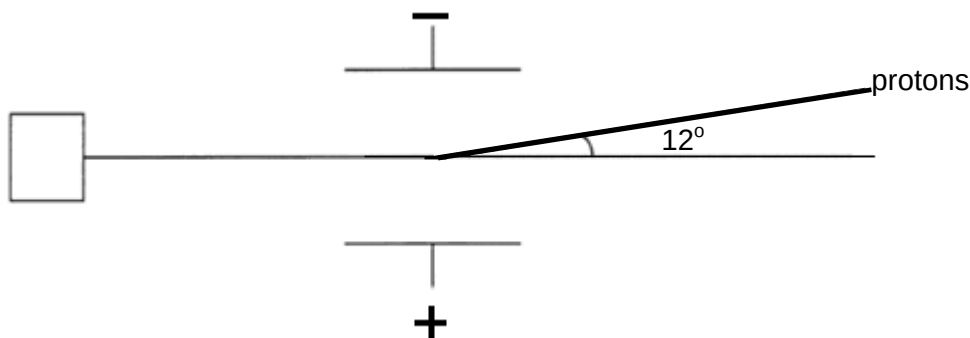
- 2 The first ionisation energies of twenty successive elements in the Periodic Table are represented in the graph.
The letters given are not the normal symbols for these elements.



Which statement about the elements and their compounds in this graph is **not** true?

- A Oxide and hydroxide of element **M** are amphoteric.
- B Oxide of element **F** has a giant covalent lattice structure.
- C Elements **B**, **J** and **R** are in Group 0 of the Periodic Table.
- D The second ionisation energy of **K** is larger than the second ionisation energy of **L**.

- 3 In an experiment, a beam of protons was passed through an electric field of constant strength. Analysis of the deflection occurring at the electric field region revealed an angle of deflection of 12° towards the negative plate.



Under identical conditions, a beam of particles, **Q**, each having 24 times the mass of a proton, was deflected by an angle of 1° towards the positive plate.

What is the overall charge on a particle of **Q**?

- A +2
 - B +3
 - C -3
 - D -2
- 4 *Use of the Data Booklet is relevant to this question.*

A typical solid fertiliser for use with household plants and shrubs contains the elements N, P, and K in the ratio of 15 g : 30 g : 15 g per 100 g of fertiliser. The recommended usage of fertiliser is 14 g of fertiliser per 5 dm^3 of water.

What is the concentration of nitrogen atoms in this solution?

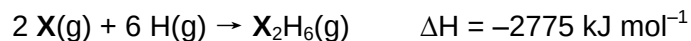
- A 0.03 mol dm^{-3}
- B 0.05 mol dm^{-3}
- C 0.42 mol dm^{-3}
- D 0.75 mol dm^{-3}

- 5 0.200 mol of a hydrocarbon undergo complete combustion to give 35.2 g of carbon dioxide and 14.4 g of water as the only products.

What is the molecular formula of the hydrocarbon?

- A C_2H_4
B C_2H_6
C C_4H_4
D C_4H_8
- 6 The ions P^{3-} , S^{2-} and Cl^- have radii 0.212nm, 0.184nm and 0.181nm respectively.
Which one of the following correctly explains the decreases in radius going from P^{3-} to Cl^- ?
- A An increase in both the total number of electrons and the nuclear charge
B An increase in the total number of electrons with the nuclear charge remaining constant
C A constant total number of electrons and an increase in the nuclear charge
D A decrease in the total number of electrons with the nuclear charge remaining constant
- 7 Which of the following species does **not** have a bond angle of 120° around the central atom(s)?
- A AlCl_3
B CH_3^+
C PH_3
D N_2O_4
- 8 In which process are hydrogen bonds broken?
- A $2\text{H}_2\text{O}(\text{l}) \rightarrow 2\text{H}_2(\text{g}) + \text{O}_2(\text{g})$
B $\text{CH}_3\text{CH}_2\text{OH}(\text{l}) \rightarrow \text{CH}_3\text{CH}_2\text{OH}(\text{g})$
C $\text{NH}_3(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{NH}_4^+(\text{aq}) + \text{OH}^-(\text{aq})$
D $\text{CH}_3\text{COOH}(\text{aq}) + \text{NaOH}(\text{aq}) \rightarrow \text{CH}_3\text{COONa}(\text{aq}) + \text{H}_2\text{O}(\text{l})$

- 9 The equation below represents the combination of gaseous atoms of non-metal **X** and of hydrogen to form gaseous **X₂H₆** molecules.

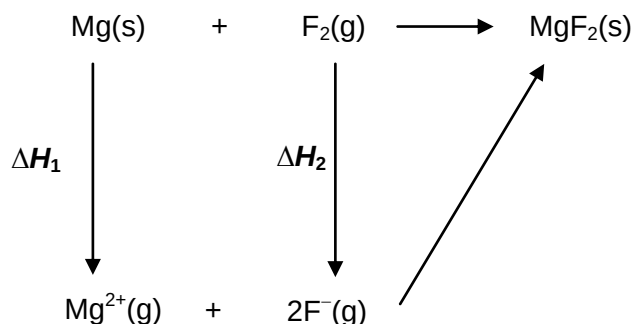


The bond energy of an **X–H** bond is 395 kJ mol^{-1} .

What is the bond dissociation energy of an **X–X** bond?

- A $-405.0 \text{ kJ mol}^{-1}$
B $-202.5 \text{ kJ mol}^{-1}$
C $+202.5 \text{ kJ mol}^{-1}$
D $+405.0 \text{ kJ mol}^{-1}$
- 10 Which of the following statements about lattice structures is **correct**?
- A The lattice energy of an ionic crystal tends to be large if the sizes of the two types of ions involved are small.
B The particles occupying lattice sites may be atoms or ions but not molecules.
C The forces holding the lattice together are so strong that the particles occupying lattice sites are held stationary.
D The lattice energy of an ionic crystal is always larger than that of a metal.

- 11 The diagram shows the Born-Haber cycle for the formation of magnesium fluoride.



ΔH_{atm} : Enthalpy change of atomization

I.E : Ionisation energy

E.A : Electron Affinity

B.E : Bond energy

Which of the following represents the correct energy changes, ΔH_1 and ΔH_2 ?

- | | ΔH_1 | ΔH_2 |
|----------|---|--|
| A | ΔH_{atm} of Mg + 1 st and 2 nd E.A of Mg | $2\Delta H_{\text{atm}}$ of F ₂ + 2(1 st I.E of F) |
| B | ΔH_{atm} of Mg + 1 st and 2 nd I.E of Mg | 2(B.E of F ₂) + 2(1 st E.A of F) |
| C | ΔH_{atm} of Mg + 1 st and 2 nd I.E of Mg | $2\Delta H_{\text{atm}}$ of F ₂ + 2(1 st I.E of F) |
| D | ΔH_{atm} of Mg + 1 st and 2 nd I.E of Mg | B.E of F ₂ + 2(1 st E.A of F) |

- 12 25 % of a solution of ethanoic acid was converted to ethanoate ions by reaction with sodium hydroxide solution at 25 °C.

What is the K_a of ethanoic acid at 25 °C given that the pH of the solution was found to be 4.28?

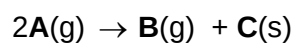
- A** 1.57×10^{-4}
B 1.31×10^{-5}
C 1.75×10^{-5}
D 5.24×10^{-5}

- 13 The solubility of iron(II) carbonate in water at 25 °C is $5.59 \times 10^{-6} \text{ mol dm}^{-3}$.

What is the numerical value of the solubility product for iron(II) carbonate when dissolved in a 0.01 mol dm^{-3} solution of iron(II) chloride at 25 °C?

- A 5.59×10^{-8}
B 5.59×10^{-10}
C 3.12×10^{-9}
D 3.12×10^{-11}

- 14 The following data is obtained during the first order thermal decomposition of



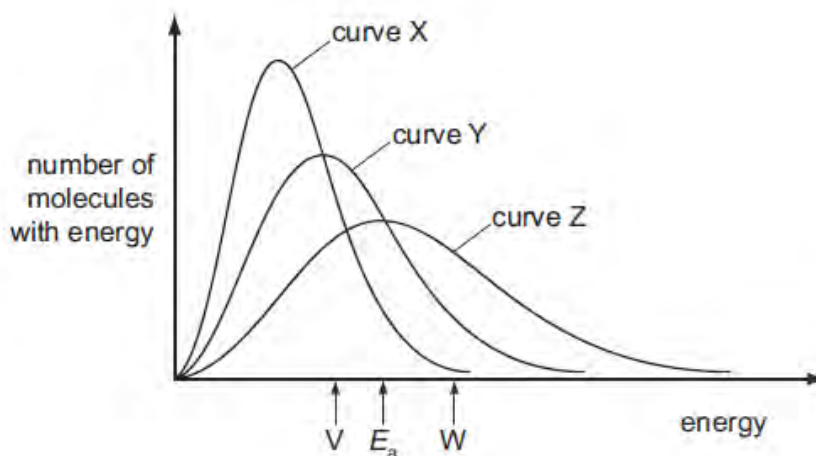
at constant volume and temperature.

Time	Total pressure in Pascal
At the end of 10 minutes of reaction	600
After completion of reaction	400

What is the rate constant for this reaction in min^{-1} ?

- A cannot be determined due to insufficient data
B 0.0346
C 0.0693
D 0.138

- 15 The curve Y and the value E_a represent the distribution of energies of the molecules and the activation energy for an uncatalysed gaseous reaction.



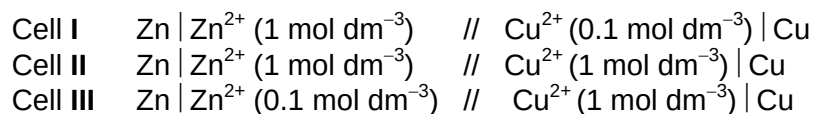
What is a possible outcome if the reaction is catalysed?

- A The distribution of energies will be given by curve Y and the activation energy by value V.
 - B The distribution of energies will be given by curve Y and the activation energy by value W.
 - C The distribution of energies will be given by curve X and the activation energy by value W.
 - D The distribution of energies will be given by curve Z and the activation energy by value V.
- 16 During the electrolysis of molten aluminium oxide to produce aluminium, using graphite (carbon) electrodes, two consecutive reactions occur at the anode, each producing a different gas.

How does the oxidation number of oxygen change in these reactions?

- A decreases by 2, then increases by 2
- B increases by 2, then decreases by 2
- C increases by 2, then decreases by 4
- D no change, then decreases by 2

- 17 E_1 , E_2 and E_3 are the emf values of the three galvanic cells I, II and III respectively.



All the statements are true except

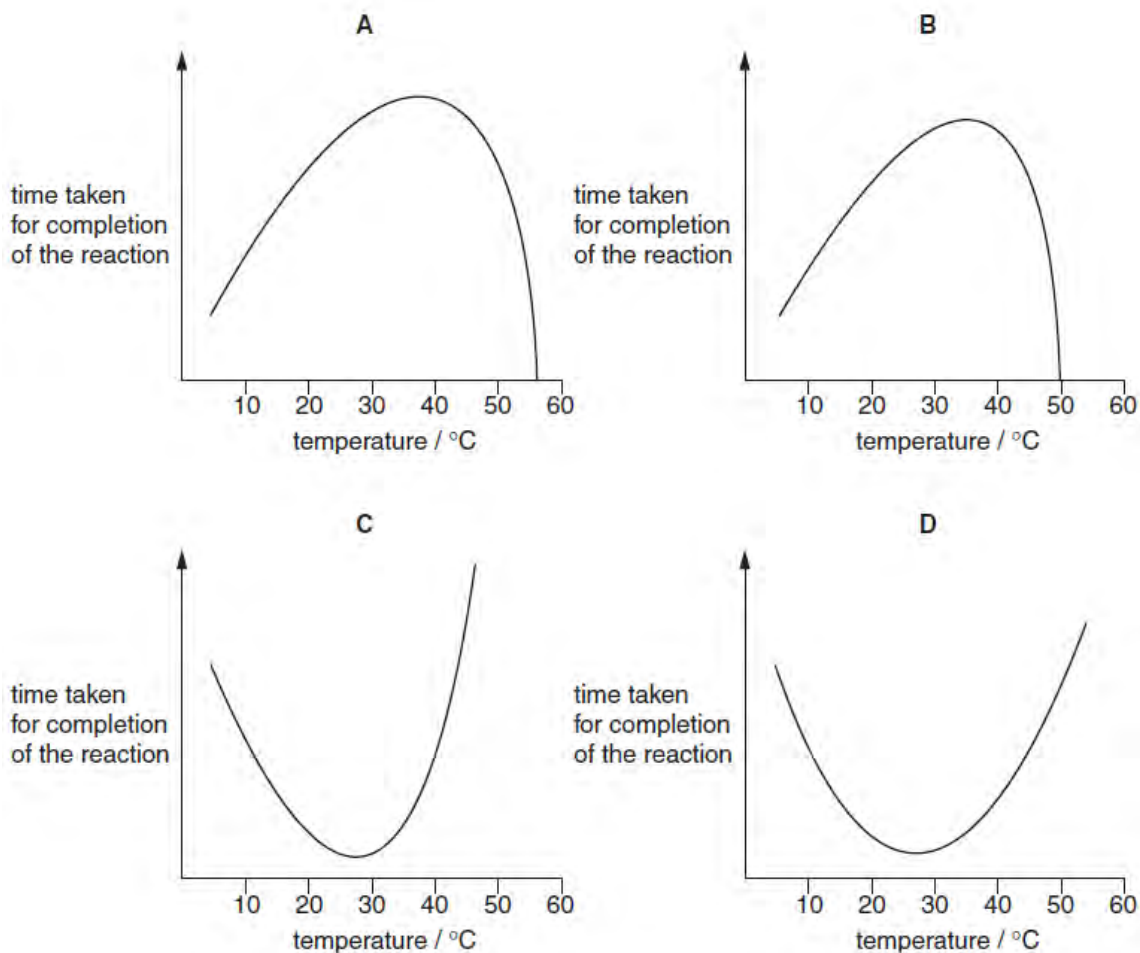
- A The emf of the three cells are of the order : $E_3 > E_2 > E_1$
- B The polarity of the copper electrode is positive only in cell II and III.
- C The colour of the solution fades in one of the compartments of each cell.
- D Electrons flow from the zinc electrode to the copper electrode in all the three cells.
- 18 The information relates to element Z.
- Z is in Period 3 of the Periodic Table.
 - Z has a lower electrical conductivity than Mg.
 - A Z atom has a half-filled subshell in its ground state.
 - Z forms an acidic oxide on exposure to air.

What is Z?

- A Na
- B Si
- C P
- D Cl
- 19 Sulfur is converted to SF_6 by fluorine, to SCl_2 by chlorine and to S_2Br_2 by bromine. Which trend does this information best provide evidence for?
- A the trend in bond energy: $\text{Cl}_2 > \text{Br}_2 > \text{F}_2$
- B the trend in electronegativity: $\text{F} > \text{Cl} > \text{Br}$
- C the trend in first ionisation energy: $\text{F} > \text{Cl} > \text{Br}$
- D the trend in oxidising ability: $\text{F}_2 > \text{Cl}_2 > \text{Br}_2$

- 20 An enzyme is completely denatured at 50 °C. A fixed concentration of this enzyme is added to a fixed concentration of its substrate. The time taken for completion of the reaction is measured at different temperatures.

Which graph shows the results?



- 21 One of the reactions taking place in a catalytic converter in a car exhaust system is between nitrogen oxide and octane (unburned petrol). The products of this reaction are non-toxic.

Which is the correct equation for the reaction?

- A $\text{C}_8\text{H}_{16} + 16 \text{NO} \rightarrow 8 \text{CO} + 8 \text{N}_2 + 8 \text{H}_2\text{O}$
- B $\text{C}_8\text{H}_{16} + 24 \text{NO} \rightarrow 8 \text{CO}_2 + 12 \text{N}_2 + 8 \text{H}_2\text{O}$
- C $\text{C}_8\text{H}_{18} + 17 \text{NO} \rightarrow 8 \text{CO} + 8 \frac{1}{2} \text{N}_2 + 9 \text{H}_2\text{O}$
- D $\text{C}_8\text{H}_{18} + 25 \text{NO} \rightarrow 8 \text{CO}_2 + 12 \frac{1}{2} \text{N}_2 + 9 \text{H}_2\text{O}$

- 22 The products obtained by cracking an alkane, **M**, are methane, ethene and propene. The mole fraction of ethene in the products is 0.5.

What is the identity of **M**?

- A C_6H_{14}
 - B C_8H_{18}
 - C C_9H_{20}
 - D $\text{C}_{11}\text{H}_{24}$
- 23 What is the total number of isomers (including stereoisomers) for an organic compound, $\text{C}_4\text{H}_9\text{F}$?
- A 3
 - B 4
 - C 5
 - D 6
- 24 What causes carbonyl groups, $\text{C}=\text{O}$, to react by a nucleophilic mechanism while alkene groups, $\text{C}=\text{C}$, react by an electrophilic mechanism?
- A oxygen is more reactive than carbon
 - B the different lengths of the double bonds
 - C the relative strengths of the double bonds
 - D the electronegativity difference between the carbon and oxygen atoms in the carbonyl group

25 Consider the following four compounds.

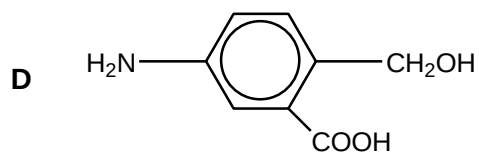
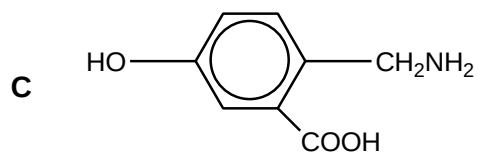
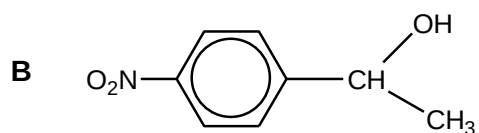
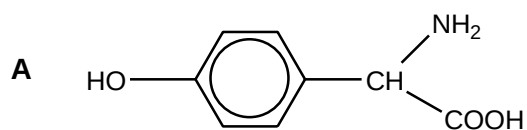
- 1 2-nitrophenol
- 2 benzoic acid
- 3 2-chlorobenzoic acid
- 4 cyclohexanol

What is the relative order of decreasing acidity of these compounds?

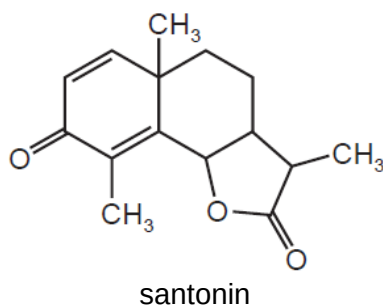
	Most acidic → Least acidic			
A	3	2	4	1
B	3	2	1	4
C	2	3	4	1
D	2	3	1	4

26 A product **P** isolated from a naturally-occurring source is established as having a molecular formula of $C_8H_9NO_3$. It possesses a chiral centre and it forms a zwitterion.

Which one of the following structures could be **P**?



- 27 Santonin is a drug that was once widely used to expel parasitic worms from the body.



When santonin is first treated with warm dilute H₂SO₄, followed by cold acidified KMnO₄, **X** is obtained.

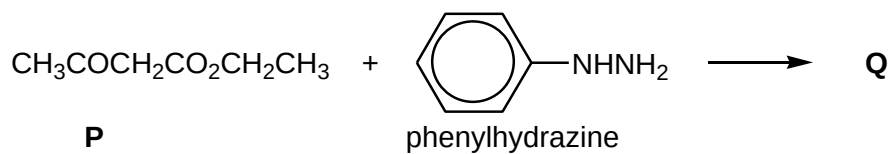
How many atoms of hydrogen in each molecule of **X** can be displaced with sodium metal?

- A** 2 **B** 4 **C** 5 **D** 6
- 28 When an isomer **F** of molecular formula C₄H₉Br undergoes hydrolysis in aqueous alkali to form an alcohol C₄H₉OH, the rate of reaction is found to be unaffected by changes in the concentration of OH⁻ ions present.

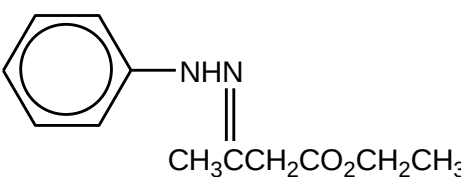
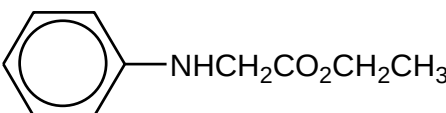
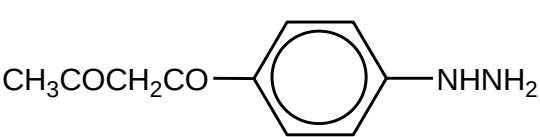
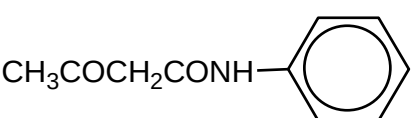
Which is the most likely molecular structure of **F**?

- A** CH₃CH₂CH₂CH₂Br
B CH₃CH₂CHBrCH₃
C (CH₃)₂CHCH₂Br
D (CH₃)₃CBr

- 29 The first stage in the synthesis of antipyrine, a drug used in reducing fever, is the reaction between compound **P** and phenylhydrazine.

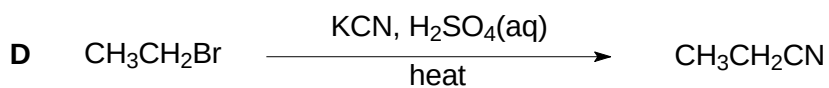
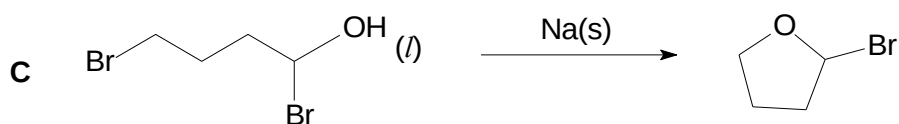
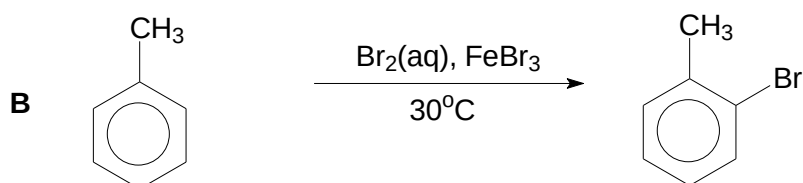
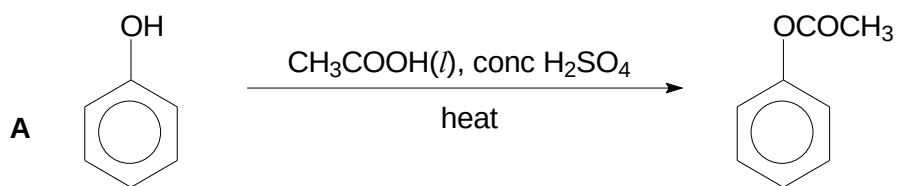


What is the structure of **Q**?

- A** 
- B** 
- C** 
- D** 

30 The reaction conditions for four different transformations are given below.

Which transformation will occur under the given conditions?



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

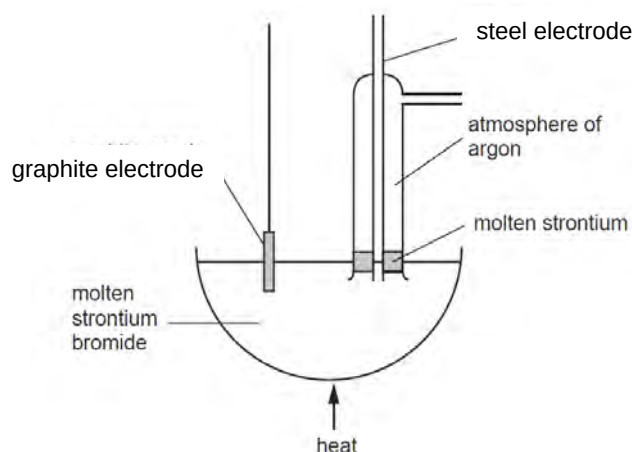
A	B	C	D
1, 2, and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

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

31 Which of the enthalpy changes of the following reactions can only be obtained by application of Hess' Law?

- 1** The hydration of anhydrous copper sulfate to form crystals of $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$.
- 2** The formation of methane from its elements.
- 3** The combustion of glucose, $\text{C}_6\text{H}_{12}\text{O}_6$.

32 Strontium metal can be obtained by the electrolysis of molten strontium bromide, SrBr_2 , using the apparatus shown in the diagram.



Which statements concerning the electrolysis are true?

- 1** 193 coulombs of electricity are needed to deposit 1×10^{-3} mol of strontium atoms at the anode.
- 2** The region around the graphite electrode turns yellow – orange.
- 3** Without the atmosphere of argon, strontium oxide would be formed.

- 33 When light is shone for a fixed period into a solution of $\text{CH}_2\text{ICH}_2\text{I}$ and I_2 in tetrachloromethane at 100°C , the following reaction occurs:

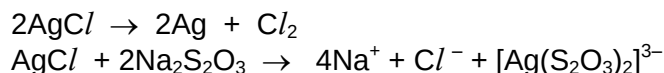


experiment	Relative initial concentration		Relative light intensity	Relative initial rate of formation of I_2
	$\text{C}_2\text{H}_4\text{I}_2$	I_2		
1	2	1	4	2
2	2	1	1	1
3	1	1	4	1
4	1	2	4	1

What conclusions about the reaction can be drawn from the data in the table?

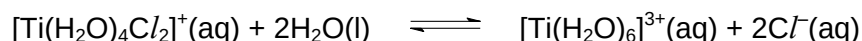
- 1 The rate of formation of iodine is proportional to initial concentration of $\text{C}_2\text{H}_4\text{I}_2$.
 - 2 The rate of formation of iodine is proportional to $\sqrt{(\text{light intensity})}$.
 - 3 Iodine is not involved in the rate determining step.
- 34 In black and white photographic film, light converts silver chloride into metallic silver. After the film has been developed, the unexposed silver chloride is removed by reaction with sodium thiosulfate to produce a 'fixed' negative.

The process can be represented by the following two reactions:



Which statements about the reactions are correct?

- 1 Both reactions involve a change of oxidation number.
 - 2 The role of sodium thiosulfate is to make the silver ions soluble.
 - 3 Both reactions have positive ΔS values.
- 35 Consider the species in the following equation.



Which statements are correct?

- 1 Water acts as a Lewis base.
- 2 The complex ions are both octahedral.
- 3 The $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$ ion can act as a Brønsted–Lowry acid.

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** Solids **W**, **X**, **Y** and **Z** are compounds of two different Group II metals. Some of their applications are described below.

- Compound **W** is used as a refractory lining material in kilns.
- Compound **X** is used as a building material. It can also be heated in a kiln to form compound **Y**.
- When **Y** is hydrated, it forms compound **Z** which is used agriculturally to treat soils.

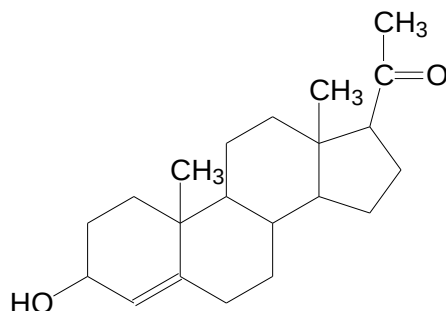
Which statements about these compounds are correct?

- 1** More acid is neutralised by 1 g of **W** than by 1 g of **X**.
 - 2** The metallic element in **W** reacts with water more quickly than the metallic element in **Y**.
 - 3** Adding **Z** to a soil decreases the pH of the soil.
- 37** Cyanohydrins are useful intermediates in organic syntheses. They can be made by reacting carbonyl compounds with hydrogen cyanide.

Which statements are correct about the reaction of propanal and hydrogen cyanide?

- 1** Propanal reacts with HCN at a faster rate than propanone.
 - 2** Propanal reacts with HCN to give a racemic mixture.
 - 3** The product obtained from the reaction can be distinguished from propanal by warming with NaOH(aq).
- 38** Which pairs of reagents will react together in a redox reaction?
- 1** $\text{CH}_4 + \text{Cl}_2$
 - 2** $\text{CH}_3\text{CH}_2\text{CHO} + \text{Fehling's reagent}$
 - 3** $\text{CH}_3\text{CH}_2\text{COCH}_3 + \text{Tollens' reagent}$

- 39 The compound shown is a hormone produced during pregnancy to suppress ovulation.



Which statements are correct?

- 1 When reacted with alkaline aqueous iodine, a yellow precipitate is observed.
 - 2 When reacted with LiAlH_4 , the product formed has 3 carbon atoms converted from sp^2 hybridised to sp^3 hybridised.
 - 3 When reacted with an excess of hot acidified $\text{K}_2\text{Cr}_2\text{O}_7$, the product formed does not decolourise aqueous bromine.
- 40 Which reactions produce an organic product containing ^{18}O atom?

- 1

$$\text{CH}_3\text{CH}_2\text{C} \begin{array}{l} \text{O} \\ \parallel \\ \text{OCH}_2\text{CH}_3 \end{array} \xrightarrow[\text{in acid medium, warm}]{\text{H}_2^{18}\text{O}}$$
- 2

$$\text{CH}_3\text{CH}_2\text{C} \begin{array}{l} \text{O} \\ \parallel \\ ^{18}\text{O}-\text{H} \end{array} + \text{CH}_3\text{CH}_2\text{NH}_2 \longrightarrow$$
- 3

$$\text{CH}_3\text{CH}_2\text{C} \begin{array}{l} \text{O} \\ \parallel \\ ^{18}\text{O}-\text{H} \end{array} + \text{CH}_3\text{CH}_2\text{OH} \xrightarrow[\text{heat}]{\text{conc H}_2\text{SO}_4}$$

– End of Paper–