

**NATIONAL JUNIOR COLLEGE
SH2 PRELIMINARY EXAMINATION**

Higher 2

CANDIDATE
NAME

SUBJECT
CLASS

REGISTRATION
NUMBER

CHEMISTRY
Paper 1 Multiple Choice

Additional Materials: Multiple Choice Answer Sheet
 Data Booklet

9647/01

Friday 16 Sept 2016

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 **20** printed pages.

Instructions on how to fill in the Optical Answer Sheet

1. Enter your NAME (as in NRIC). TAN AH TECK
2. Enter the SUBJECT TITLE. CHEMISTRY
3. Enter the TEST NAME. SH2 Prelim 2016
4. Enter the CLASS. 1505648

RUB OUT ERRORS THOROUGHLY

USE PENCIL ONLY
FOR ALL ENTRIES ON THIS SHEET

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Example:

Shade the index number in a 5 digit format on the optical answer sheet: 2nd digit and the last 4 digits of the Registration Number.

Student	Example of Registration No.	Shade
Tan Ah Teck	<u>1505648</u>	55648

Section A

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

- 1 3 g of hydrogen reacted with 160 g of bromine gas to give hydrogen bromide, HBr.

How many molecules are present at the end of the reaction?

A 6.02×10^{23}

C 12.0×10^{23}

B 9.03×10^{23}

D 15.1×10^{23}

- 2 In an experiment, 50 cm³ of a 0.1 mol dm⁻³ solution of a metallic salt reacts exactly with 25 cm³ of 0.1 mol dm⁻³ aqueous sodium sulfite.

The half-equation for the oxidation of sulfite ion is shown below:



If the original oxidation number of the metal ion is +3, what is the new oxidation number of the metal ion?

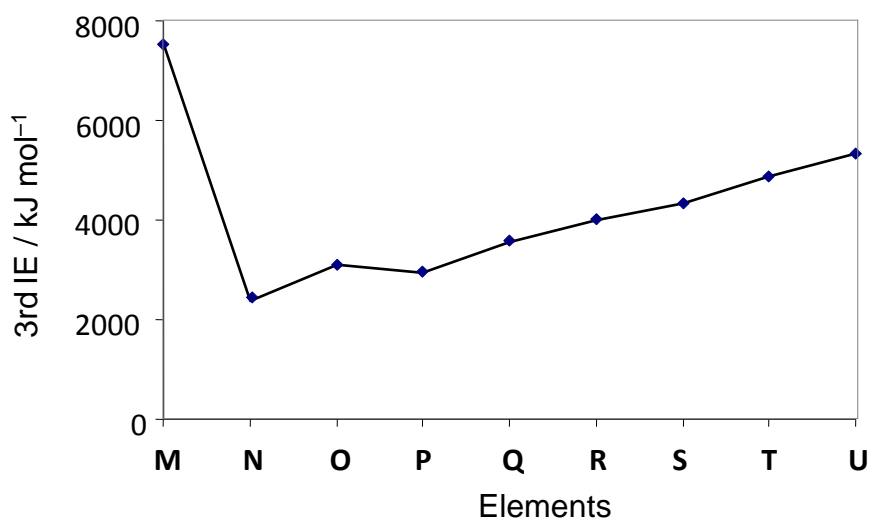
A 0

B 1

C 2

D 4

- 3 The graph below shows the variation in the **third** ionisation energies for the consecutive elements **M** to **U** in the Periodic Table, all with proton number below 20. The symbols **M** to **U** do not represent the actual elements.



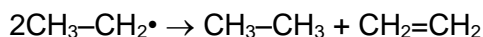
What can be deduced from the above graph?

- A** **M** has a noble gas configuration.
- B** **M** reacts with **R** to form compound **MR₂**.
- C** The atomic radius of **T** is smaller than that of **S**.
- D** The decrease in 3rd I.E from **O** to **P** is due to inter-electronic repulsion.
- 4 Which set of compounds includes a giant ionic structure, a giant covalent structure and a simple covalent structure?
- A** C₆₀, C₂H₅CO₂NH₄, SiO₂
- B** Al₂O₃, PbO, SiO₂
- C** CO₂, Na₂O, SO₂
- D** AlCl₃, P₄O₆, KHF₂
- 5 Which pair of species has the same bond angle?
- A** IF₃, NF₃
- B** NO₂, SO₂
- C** XeF₄, CF₄
- D** NO₃⁻, CO₃²⁻

- 6 Which statement best explains why iodine is a solid while water is a liquid at room temperature?
- A Iodine has a much larger molar mass than water.
 - B Iodine has stronger and more extensive covalent bonds between its atoms in its molecular structure.
 - C The van der Waals' forces of attraction between iodine molecules are stronger than the intermolecular hydrogen bonding in water.
 - D The intermolecular hydrogen bonding in water is stronger than the intermolecular van der Waals' forces of attraction in iodine.
- 7 How does the volume of a 1.0 dm^3 sample of gas change when it is heated from 20°C to 40°C at constant pressure?
- A It increases to about 1.1 dm^3 .
 - B It increases to about 2.0 dm^3 .
 - C It decreases to about 0.9 dm^3 .
 - D It decreases to about 0.5 dm^3 .
- 8 The data below refer to gas phase reactions at constant pressure.



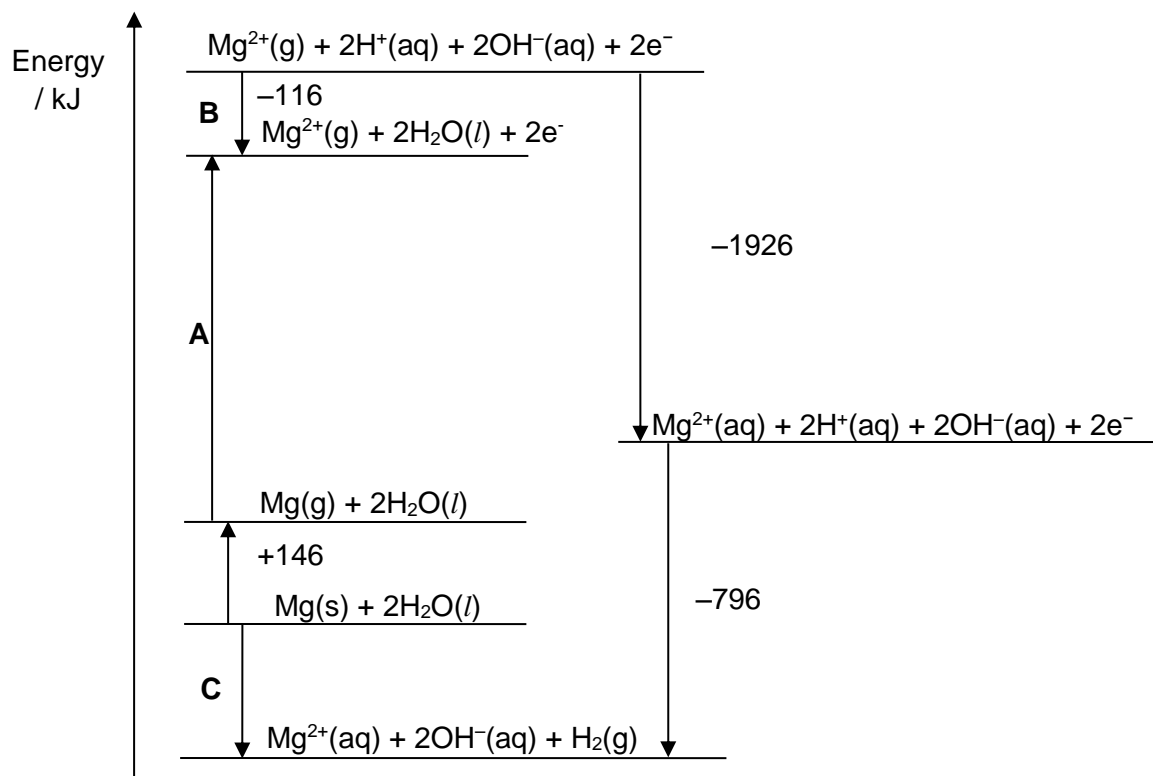
What is the enthalpy change for the following reaction?



- A $+244 \text{ kJ mol}^{-1}$
- B -122 kJ mol^{-1}
- C -244 kJ mol^{-1}
- D -580 kJ mol^{-1}

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

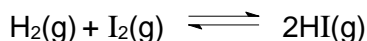
The energy level diagram shown below involves magnesium and water.



Which statement is **incorrect**?

- A Step A represents the first and second ionisation energies of magnesium.
- B Step B represents $2 \times \Delta H_f(\text{H}_2\text{O})$.
- C The enthalpy change for step C is -274 kJ mol^{-1} .
- D The enthalpy change of hydration of magnesium ion is $-1926 \text{ kJ mol}^{-1}$.

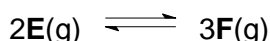
- 10 Measured amounts of hydrogen and iodine are allowed to reach an equilibrium at 300 °C in a container of known volume.



From which experimental method can the equilibrium constant, K_c , be determined?

- A measuring the total pressure in the container
- B slow cooling to 25 °C, breaking open the container under aqueous potassium iodide, and titrating the iodine present with aqueous sodium thiosulfate
- C rapid cooling to 25 °C, breaking open the container under aqueous potassium iodide, and titrating the iodine present with aqueous sodium thiosulfate
- D withdrawal of a measured sample of the equilibrium mixture, followed by complete decomposition of the hydrogen iodide present, and then titrating the total amount of iodine with aqueous sodium thiosulfate

- 11 For the reaction:



the numerical values of the equilibrium constant, K_p , are 1.50×10^7 at 500 K and 1.60×10^6 at 600 K.

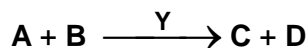
Which statement about the equilibrium is true?

- A Decreasing the pressure increases the proportion of **E** in the equilibrium mixture.
 - B Adding a catalyst increases the proportion of **F** in the equilibrium mixture.
 - C The forward reaction is endothermic.
 - D The reaction is feasible at all temperatures.
- 12 The rate of removal of paracetamol, a pain-killing drug, from the body is a first order reaction with a rate constant, $k = 0.26 \text{ h}^{-1}$.

How long will it take to remove 75% of the paracetamol that a patient consumes?

- A 0.20 h B 0.26 h C 2.7 h D 5.3 h

- 13 Using a colorimeter, the following reaction is studied by finding the time taken for a coloured reactant, **A**, to decolourise. The reaction is catalysed by **Y**.



The following results are obtained:

Experiment	Vol of solution added / cm ³				Time taken / s
	A	B	Y	H ₂ O	
1	10	20	10	10	20
2	10	10	10	20	40
3	10	20	5	15	40
4	5	20	10	15	10

What is the rate equation for the reaction?

A rate = $k[\text{A}][\text{B}]$

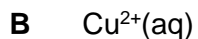
C rate = $k[\text{B}][\text{Y}]$

B rate = $k[\text{A}][\text{Y}]$

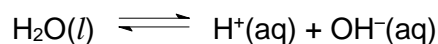
D rate = $k[\text{A}][\text{B}][\text{Y}]$

- 14 Use of the Data Booklet is relevant to this question.

Which reagent can be used to convert $\text{Na}_4\text{Fe}(\text{CN})_6$ to $\text{Na}_3\text{Fe}(\text{CN})_6$?



- 15 Water dissociates into ions to establish following equilibrium:



Which is true about the dissociation of water?

A Dissociation of water is an exothermic process.

B When temperature increases, pH becomes lower than pOH.

C Water is only neutral at room temperature.

D For pure water, the values of its dissociation constant (K_a), ionic product (K_w) and $[\text{H}^+]$ increase in the order: $K_a < K_w < [\text{H}^+]$.

- 16 Bromocresol green indicator has a pH range of 3.8 – 5.5. It is yellow at pH < 3.8 and blue at pH > 5.5.

Which statement about bromocresol green is **incorrect**?

- A The indicator is suitable for a strong acid–weak base titration.
- B The indicator is yellow in 0.10 mol dm⁻³ of an acid with $K_a = 10^{-5}$ mol dm⁻³.
- C The indicator is green in a solution containing equimolar concentrations of CH₃CO₂H and CH₃CO₂K. (pK_b of CH₃CO₂K = 9.24)
- D When an acid in the conical flask is titrated against a base, the indicator changes from yellow to blue at the end-point.

- 17 Four compounds of some Period 3 elements are listed below.

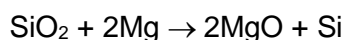


Water is added separately to each compound. Pairs of the resulting solutions are mixed together.

Which pair of solutions would give a solution of pH 7?

- A NaCl and Na₂O
- B Na₂O and SiCl₄
- C NaCl and SO₂
- D SiCl₄ and SO₂

- 18 In the preparation of silicon, silicon dioxide is heated with magnesium.



The product mixture contains only MgO and Si only.

To separate the silicon from the product mixture, a student proposed the following methods.

- 1 Shake the mixture with aqueous hydrochloric acid and filter.
- 2 Heat the mixture gently and collect the evaporated silicon.

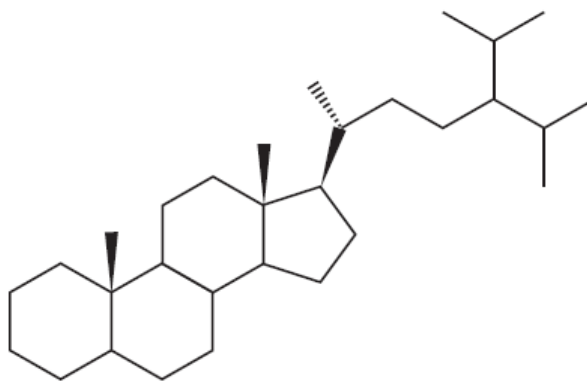
Which methods would work?

- A 1 only
- B 2 only
- C 1 and 2
- D neither 1 or 2

- 19 The high reactivity of fluorine is largely due to the low energy of the F–F bond.

Which statement best accounts for the weak F–F bond?

- A** The F–F bond is weak because of the repulsion between the non-bonding electrons.
- B** The F–F bond is weak because of the short bond length.
- C** The F–F bond is weak because of the small nuclear charge of fluorine atom.
- D** The F–F bond is weak because of the small size of fluorine atom.
- 20 The molecule 24-isopropylcholestane, which has been isolated from a class of sponge, can serve as a biomarker and has determined the first revolutionary appearances from some species.



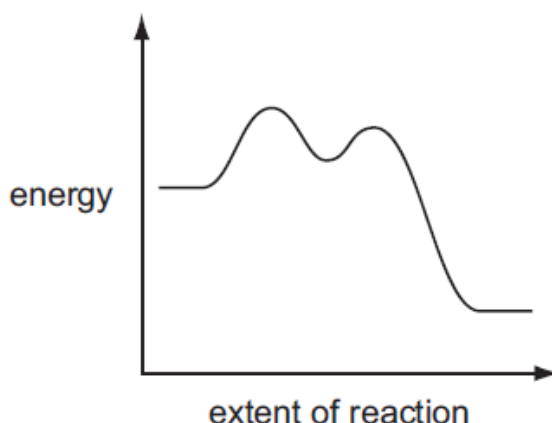
24-isopropylcholestane

Carbon atoms in a hydrocarbon molecule are classified as primary, secondary, tertiary or quaternary, depending on whether they are directly bonded to one, two, three or four other carbon atoms.

How many tertiary and chiral carbon atoms are present in a molecule of 24-isopropylcholestane?

	number of tertiary carbon atoms	number of chiral carbon atoms
A	9	4
B	9	8
C	11	4
D	11	8

21 A reaction pathway diagram is shown below.



Which reactions could have this profile?

- I $(\text{CH}_3)_3\text{CBr} + \text{NaOH} \rightarrow (\text{CH}_3)_3\text{COH} + \text{NaBr}$
- II $\text{CH}_3\text{CH}_2\text{Br} + \text{NaOH} \rightarrow \text{CH}_3\text{CH}_2\text{OH} + \text{NaBr}$
- III $\text{C}_6\text{H}_5\text{CH}_2\text{Cl} + \text{NH}_3 \rightarrow \text{C}_6\text{H}_5\text{CH}_2\text{NH}_2 + \text{HCl}$
- IV $(\text{CH}_3)_3\text{CCH}_2\text{CH}_2\text{Cl} + \text{NH}_3 \rightarrow (\text{CH}_3)_3\text{CCH}_2\text{CH}_2\text{NH}_2 + \text{HCl}$

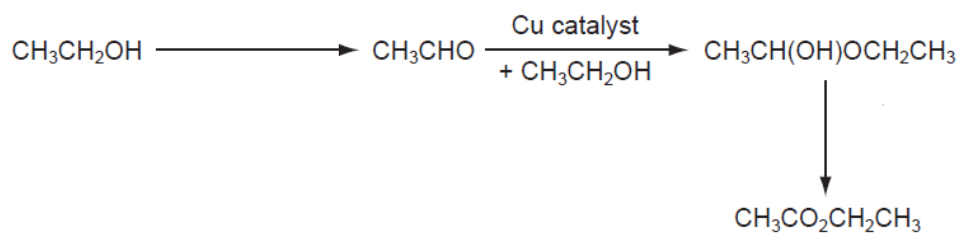
- A I and II only
- B I and III only
- C II and IV only
- D II, III and IV only

22 The alkanes used to be known as the paraffin hydrocarbons – paraffin meaning “lack of affinity” (i.e. unreactive).

Which statement is best explains the “lack of affinity” in alkanes?

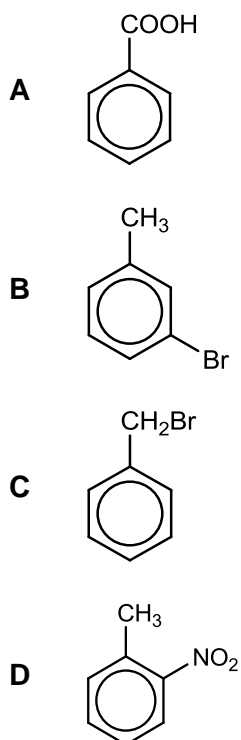
- A The atoms are arranged tetrahedrally around each carbon atom.
- B The alkanes have van der Waals forces of interaction.
- C There are no significant dipole moments in C–H and C–C bonds.
- D There is free rotation about C–C single bonds.

- 23 A new industrial preparation of ethyl ethanoate has been developed using cheap sources of ethanol.

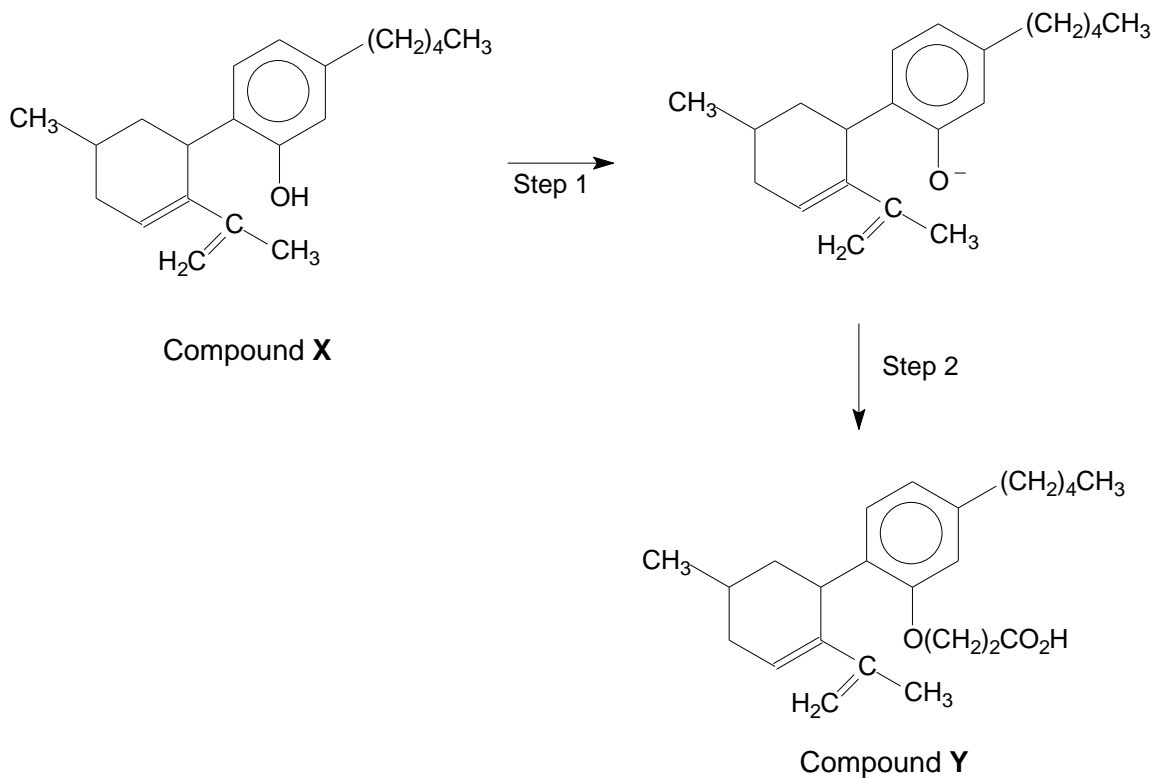


Which type of reaction is involved at some stage of this reaction sequence?

- A nucleophilic addition
 - B condensation
 - C disproportionation
 - D reduction
- 24 Which compound is least likely to be prepared directly from methylbenzene?



25 Compound Y can be prepared from compound X in the following reaction sequence.

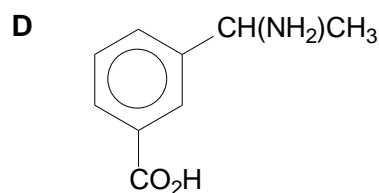
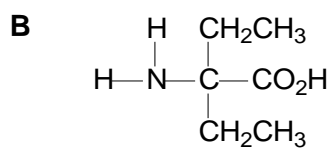
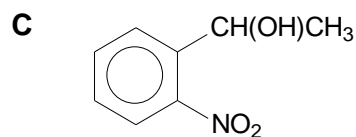
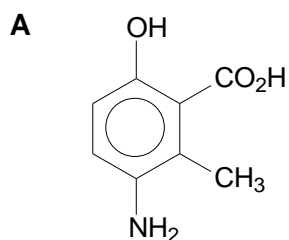


Which reagents can be used to prepare compound Y?

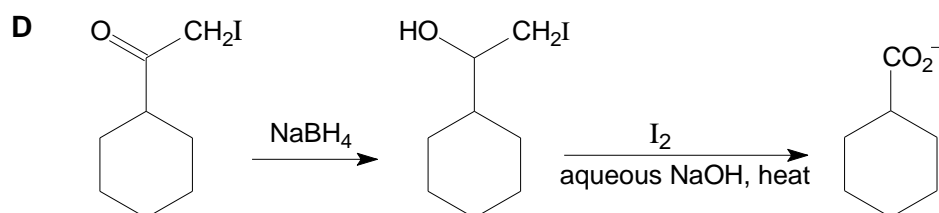
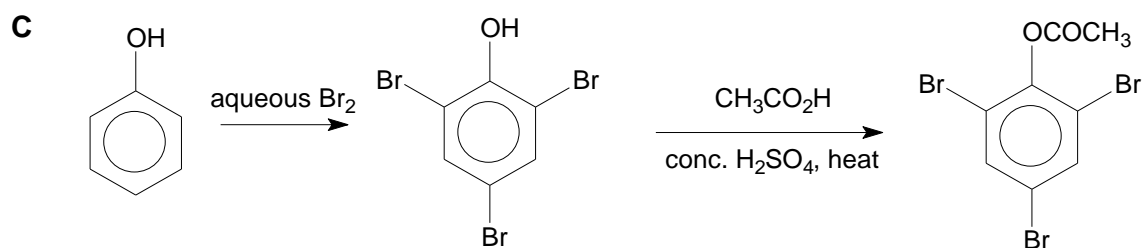
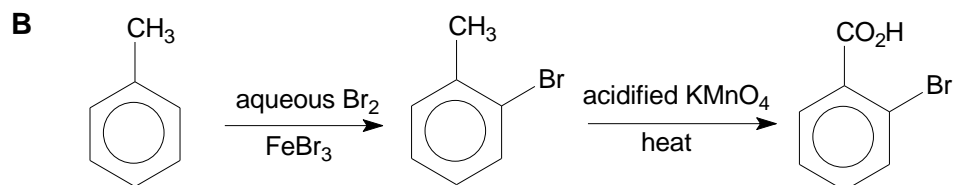
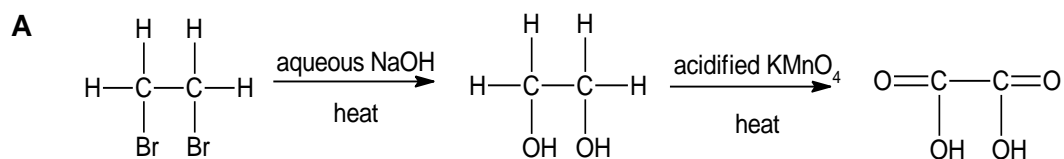
	Step I	Step II
A	Na	$\text{CH}_2(\text{OH})(\text{CH}_2)_2\text{CO}_2\text{H}$
B	NaOH	$\text{CH}_2\text{C}/\text{CH}_2\text{CO}_2\text{H}$
C	NaOH	$\text{CH}_2\text{C}/\text{CH}_2\text{CH}_2\text{CO}_2\text{H}$
D	Na_2CO_3	$\text{CH}_2(\text{OH})\text{CH}_2\text{CO}_2\text{H}$

26 Compound **Z** is optically active and exists as zwitterions.

Which could be the structure of **Z**?

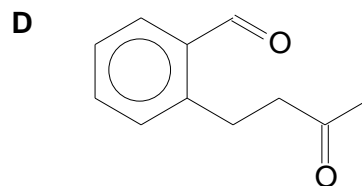
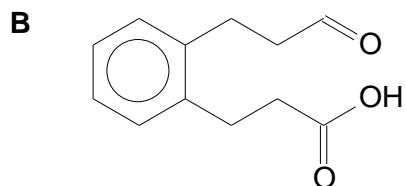
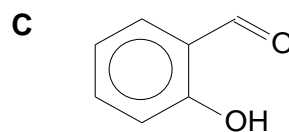
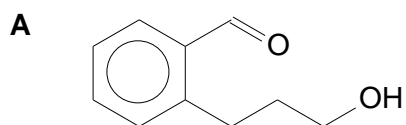


27 Which is the most feasible synthetic route?



- 28 Compound **Y** gives a positive result when treated with $[\text{Ag}(\text{NH}_3)_2]^+$ and PCl_5 but a negative result when treated with alkaline $\text{Cu}(\text{II})$ tartrate.

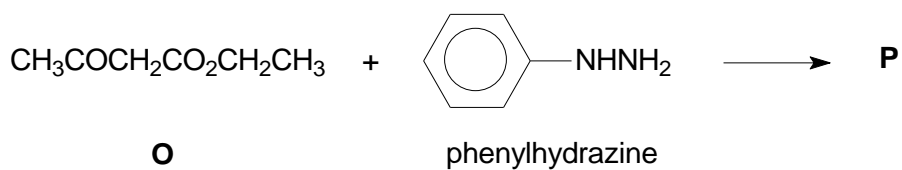
What could **Y** be?



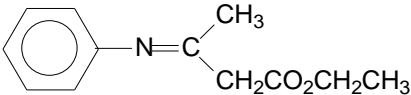
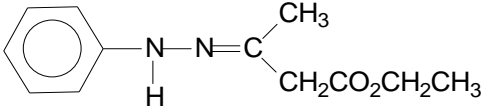
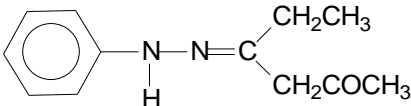
- 29 What is the order of increasing $\text{p}K_a$ of the organic compounds?

- A** $\text{CCl}_3\text{CH}_2\text{OH}$, $\text{CHCl}_2\text{CH}_2\text{OH}$, $\text{CH}_3\text{CO}_2\text{H}$
- B** $\text{CH}_3\text{CHClCO}_2\text{H}$, $\text{CH}_3\text{CH}_2\text{CO}_2\text{H}$, $\text{C}_6\text{H}_5\text{OH}$
- C** $\text{C}_6\text{H}_5\text{OH}$, $\text{CH}_3\text{CHClCO}_2\text{H}$, $\text{CH}_3\text{CHF}_2\text{CO}_2\text{H}$
- D** $\text{CH}_2\text{ClCH}_2\text{CO}_2\text{H}$, $\text{CH}_3\text{CHClCO}_2\text{H}$, $\text{CH}_3\text{CH}_2\text{CO}_2\text{H}$

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



What is **P**?

- A** $\text{CH}_3\text{COCH}_2\text{CONH}-\text{C}_6\text{H}_5$
- B** 
- C** 
- D** 

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 For which pair does the first species contain more unpaired electrons than the second species?

- 1** N^- , C^+
- 2** Mn^{2+} , Co^{2+}
- 3** Mn^{4+} , Co

32 Which reactions represent standard enthalpy changes?

- 1** $\text{NH}_3(\text{g}) + \text{HCl}(\text{g}) \rightarrow \text{NH}_4\text{Cl}(\text{s})$
- 2** $6\text{C}(\text{s}) + 6\text{H}(\text{g}) \rightarrow \text{C}_6\text{H}_6(\text{l})$
- 3** $\text{CH}_3\text{OH}(\text{l}) + \frac{3}{2}\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{g})$

33 At 298 K, the numerical values for the dissociation constant of the aliphatic carboxylic acids, RCO_2H and $\text{R}_1\text{CO}_2\text{H}$ in aqueous solution are 2.1×10^{-8} and 2.2×10^{-4} respectively.

Which statements can be inferred from the given information?

- 1** The pH of $1 \text{ mol dm}^{-3} \text{RCO}_2\text{H}$ is greater than $1 \text{ mol dm}^{-3} \text{R}_1\text{CO}_2\text{H}$.
- 2** The K_b of RCO_2^- is greater than that of R_1CO_2^- .
- 3** The acid strength of RCO_2H is greater than that of $\text{R}_1\text{CO}_2\text{H}$.

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 Which statements correctly describe the role of ammonia in the reactions below?

	<i>reaction</i>	<i>role of ammonia</i>
1	$\text{CuO} + 6\text{NH}_3 \rightarrow [\text{Cu}(\text{NH}_3)_4]^{2+} + 2\text{NH}_2^- + \text{H}_2\text{O}$	Brønsted acid
2	$2\text{Na} + 2\text{NH}_3 \rightarrow 2\text{NaNH}_2 + \text{H}_2$	oxidising agent
3	$\text{CH}_3\text{Cl} + \text{NH}_3 \rightarrow \text{CH}_3\text{NH}_2 + \text{HCl}$	Brønsted base

35 Barium sulfate is opaque to X-rays and barium ions are toxic to humans. In hospitals, before an X-ray examination is carried out, patients with digestive tract problems are sometimes given a 'barium meal', consisting of a suspension of barium sulfate in water.

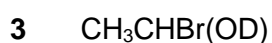
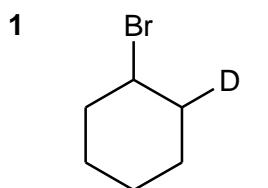
[Given: K_{sp} of $\text{BaSO}_4 = 1.3 \times 10^{-10} \text{ mol}^2 \text{ dm}^{-6}$; K_{sp} of $\text{BaCO}_3 = 5.5 \times 10^{-10} \text{ mol}^2 \text{ dm}^{-6}$]

Which statements regarding the 'barium meal' are true?

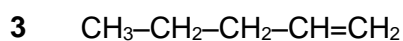
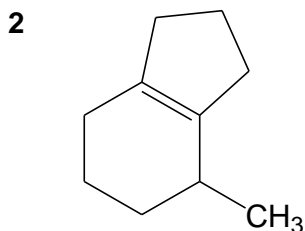
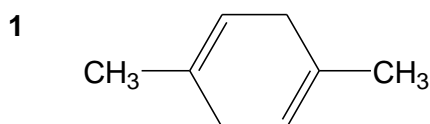
- 1** Barium sulfate is used because it is insoluble in water and hence is not poisonous when ingested by mouth.
- 2** Barium carbonate can be used since it is also insoluble in water.
- 3** Barium hydroxide can also be used since it is thermally stable in the human body.

- 36 Deuterium, D, is the ${}^2_1\text{H}$ isotope of hydrogen. DBr has the same chemical properties as HBr.

Which compounds could be made by the reaction of DBr with another compound in a single reaction?

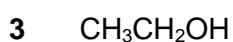
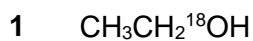


- 37 Which compounds form a single organic product when each is heated separately with acidified potassium manganate(VII) solution?



- 38 Ethyl propanoate, $\text{CH}_3\text{CH}_2\text{OCOCH}_2\text{CH}_3$ undergoes acidic hydrolysis in the presence of H_2^{18}O .

Which products are formed?



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

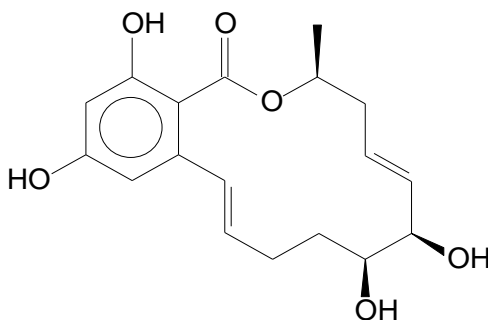
No other combination of statements is used as a correct response.

- 39** The structure of benzene, C_6H_6 , is a regular hexagon in which the π electrons are described as delocalised.

Which statements support this structure?

- 1** Benzene does not undergo addition reactions.
- 2** The length of the C-C bonds in benzene are intermediate between C–C bond in an alkane and C=C bond in an alkene.
- 3** The hydrogenation of benzene is less exothermic than that predicted for cyclohexa-1,3,5-triene.

- 40** *Aigialomycin D*, a fungal metabolite, has the structure shown below.



Aigialomycin D

Which observations are correct?

- 1** It reacts with hot, acidified $K_2Cr_2O_7$ to give a diketone.
- 2** One mole of *Aigialomycin D* reacts with Na metal to produce 2 moles of hydrogen.
- 3** It reacts with cold, dilute acidified $KMnO_4$ to give a product that has 7 chiral centres in each molecule.

– End of Paper–