NATIONAL JUNIOR COLLEGE
SH2 PRELIMINARY EXAMINATION
Higher 2

CANDIDATE
NAME

SUBJECT
CLASS

REGISTRATION
NUMBER

CHEMISTRY
Paper 1 Multiple Choice

9647/01

Additional Materials: Multiple Choice Answer Sheet

Data Booklet

Thu 18 Sep 2014
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 **18** printed pages.

Section A

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

1 Tin(IV) iodide can be prepared by refluxing 0.04 moles of tin with 0.03 moles of iodine dissolved in 50 cm^3 of tetratchloromethane (boiling point: 77 ^{o}C).

$$Sn + 2I_2 \rightarrow SnI_4$$
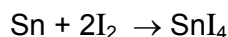
Orange crystals of the product are obtained by filtering the hot reaction mixture and then cooling the filtrate.

Which of the following would indicate that the reaction is complete?

A The boiling point of the reaction mixture is 77 ^{o}C.

B No tin remains in the reaction flask.

C Crystallisation occurs in the boiling solvent.

D No more purple vapour is observed in the reaction vessel.

2 When an excess of KI was added to 5.0 cm^3 of a 0.400 mol dm^{-3} solution of AO_4^{3-}, 8.00 cm^3 of 0.500 mol dm^{-3} of $Na_2S_2O_3$ is required to react completely with the iodine liberated.

What is the final oxidation state of **A**?

A −3 **B** +1 **C** +2 **D** +3

3 Which equation corresponds to the third ionisation energy of titanium (Ti)?

A $Ti(g) \rightarrow Ti^{3+}(g) + 3e^-$

B $Ti^{2+}(s) \rightarrow Ti^{3+}(g) + e^-$

C $Ti^{2+}(g) \rightarrow Ti^{3+}(g) + e^-$

D $Ti^{3+}(g) + e^- \rightarrow Ti^{2+}(g)$

4 A 1.0 dm^3 sample of gas is heated from 27 °C to 54 °C under constant pressure.

What will be the new volume of the gas at 54 °C?

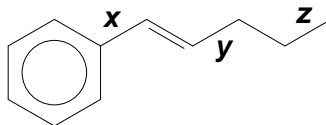**A** 0.5 dm^3 **B** 0.9 dm^3 **C** 1.1 dm^3 **D** 2.0 dm^3

5   The following graphs show the ideal gas relationship for 2 different ideal gases. Gas **P** has twice the amount of particles as gas **Q**.

Which graph is correct?

A

B

C

D
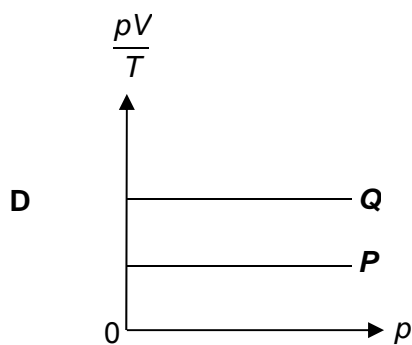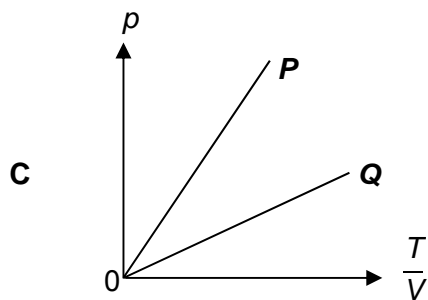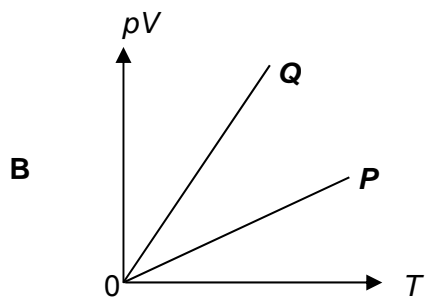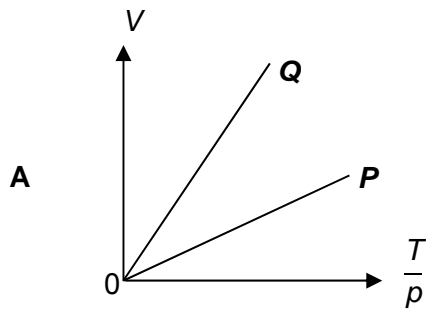
6 Three carbon–carbon bonds are labelled in the diagram.

Which bond is made up of an sp^2–sp^3 overlap?

A *y* only

B *z* only

C *x* and *y* only

D *x*, *y* and *z*

7 Which of the following species has a bond angle of 120° around the central atom?

A NCl_3 **B** N_3^- **C** BBr_3 **D** H_3O^+

8 Enthalpy changes for the following reactions can be determined experimentally:

$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$ $\Delta H_{rxn} = -93$ kJ mol^{-1}

$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$ $\Delta H_{rxn} = -242$ kJ mol^{-1}

$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(l)$ $\Delta H_{rxn} = -906$ kJ mol^{-1}

What is the enthalpy change of formation of NO(g)?

A + 90 kJ mol^{-1}

B +180 kJ mol^{-1}

C +360 kJ mol^{-1}

D +1270 kJ mol^{-1}

9 61.8 kJ of energy is required to vaporise 320 g of liquid bromine at its boiling point of 59 °C.

What is the entropy change of vaporisation for bromine at 59 °C?

A +0.093 kJ mol^{-1} K^{-1}

B +0.186 kJ mol^{-1} K^{-1}

C +0.523 kJ mol^{-1} K^{-1}

D +1.050 kJ mol^{-1} K^{-1}

10 The following reaction is used industrially to produce a combustible gas from coal.

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

A mixture of powdered coal and steam at a pressure of 1 atm was allowed to reach equilibrium at a constant temperature of 500 K. At equilibrium, the total pressure had increased to 1.9 atm.

What is the numerical value of the equilibrium constant, K_p, at 500 K?

A 1.9   **B** 3.24   **C** 8.1   **D** 81

11 The titration curve below shows the reaction between a solution of 0.10 mol dm^{-3} weak acid, $H_2C_2O_4$, and 0.20 mol dm^{-3} aqueous sodium hydroxide.
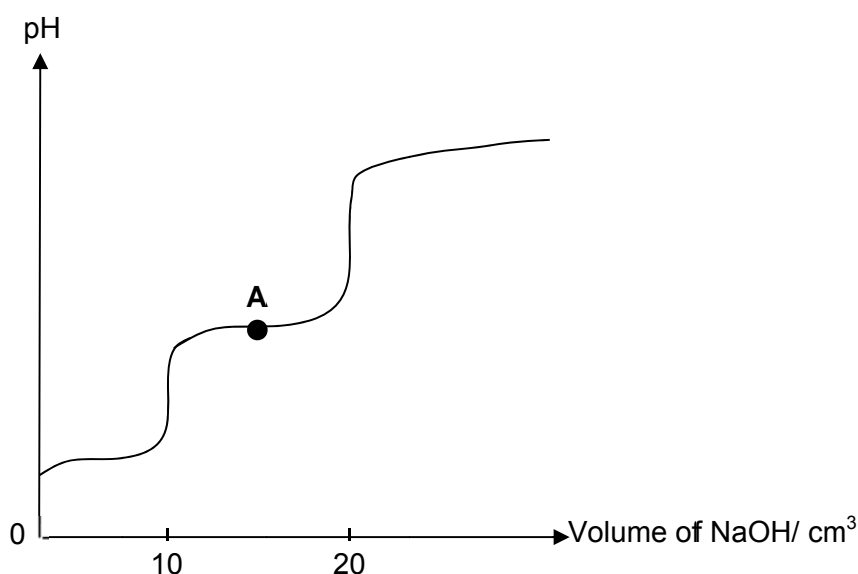

Which statement is correct?

A Methyl orange cannot be used as an indicator in a titration to verify the concentration of $H_2C_2O_4$.

B The volume of $H_2C_2O_4$ used in this titration is 40 cm^3.

C There are equal amounts of $HC_2O_4^-$ and $C_2O_4^{2-}$ present at point **A**.

D The resultant solution formed has more H$^+$ than OH$^-$ when 20 cm^3 of NaOH has been added.

12 Which statement is **not** a correct description of a strong monoprotic acid?

    A   It can have a higher pH than a weak acid.

    B   It has a relatively high electrical conductivity in dilute solution.

    C   It requires the same volume of alkali for complete neutralisation compared to a weak monoprotic acid of the same concentration.

    D   It forms an acidic buffer when 0.1 mole of sodium hydroxide is added to 0.2 mole of a strong monoprotic acid.

13 Hydrogen peroxide reacts with acidified iodide ions liberating iodine according to the equation below:
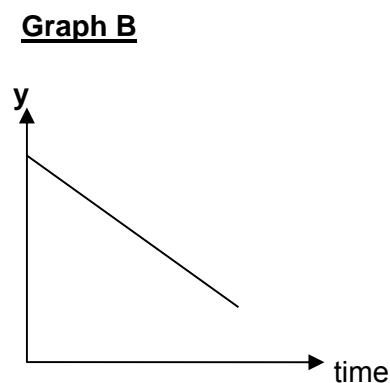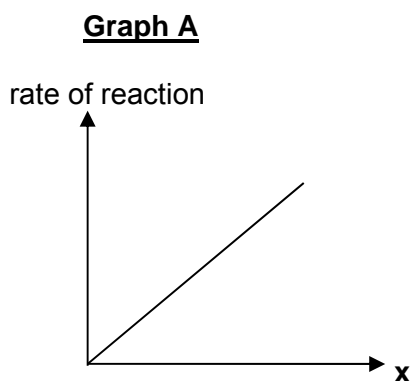
$$H_2O_2(aq) \ + \ 2H^+(aq) \ + \ 2I^-(aq) \ \rightarrow \ I_2(aq) \ + \ 2H_2O(l)$$
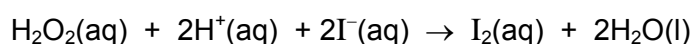
The kinetics of this reaction were investigated and it was found to have the following rate equation:

$$\text{rate} = k[H_2O_2][I^-]$$

Two series of experiments were conducted giving rise to **Graph A** and **Graph B**.

The concentrations of reagents used for both experiments were as follows:

$[H_2O_2] = 0.1 \text{ mol dm}^{-3}$, $[I^-] = 0.1 \text{ mol dm}^{-3}$, $[H^+] = 0.01 \text{ mol dm}^{-3}$

      Graph A   **Graph B**

Which combination shows the correct labelling of the x-axis for **Graph A** and y-axis for **Graph B**?

|	x-axis for Graph A	y-axis for Graph B
A	$[I^-][H^+] / \text{mol}^2 \text{ dm}^{-6}$	$[H_2O_2] / \text{mol dm}^{-3}$
B	$[H_2O_2][I^-] / \text{mol}^2 \text{ dm}^{-6}$	$[H^+] / \text{mol dm}^{-3}$
C	$[H_2O_2] / \text{mol dm}^{-3}$	$[H^+] / \text{mol dm}^{-3}$
D	$[I^-] / \text{mol dm}^{-3}$	$[H_2O_2] / \text{mol dm}^{-3}$

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

When a solution of sulfuric acid is electrolysed, gas **J** and gas **K** are produced at the cathode and the anode respectively in the molar ratio 2:1. In another experiment, the same quantity of electricity is used to electrolyse a saturated sodium chloride solution and a gas **L** is evolved at the anode.

What is the molar ratio of **J** : **K** : **L**?

A   2:1:1   B   2:1:2   C   4:2:1   D   4:2:3

15 The diagram below is an experimental set-up by a student to purify a piece of impure copper.

$Cu(NO_3)_2$ (aq) at 1 mol dm^{-3}
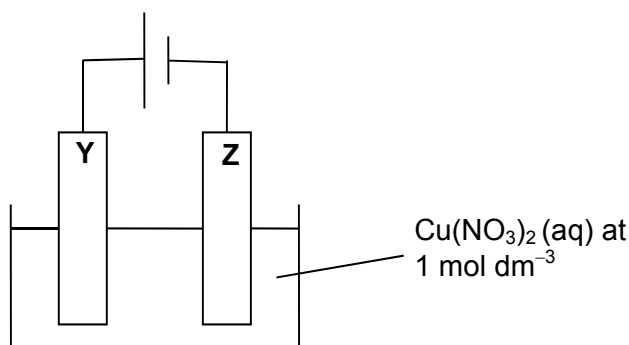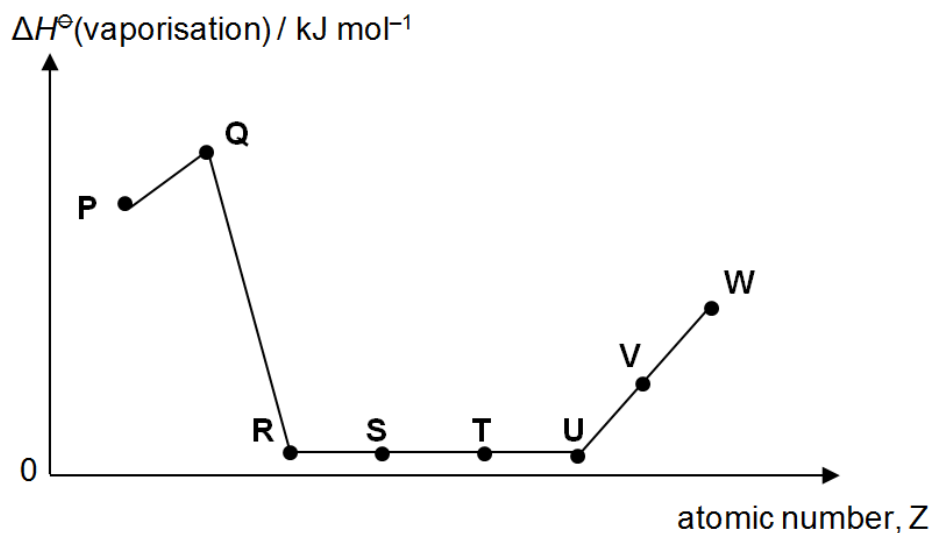
Which statement is correct?

A   The student should place the impure copper as electrode **Z**.

B   The blue $Cu(NO_3)_2$ solution fades during the process of purification of copper.

C   The change in mass for each electrode is different.

D   The mass of copper deposited is 1.43 g when a current of 0.2 A flows for 3 hours in the above setup.

16 Aluminium is the third most abundant element in the Earth's crust.

Which statement is **not** true of its compounds?

A   A solution of aluminium chloride turns blue litmus red.

B   Aluminium chloride can be prepared by passing chlorine gas over heated aluminium metal.

C   Aluminium fluoride has a much higher melting point than aluminium bromide.

D   The pH of aluminium oxide in water is 7 because it can react with both aqueous acids and alkalis.

17 The graph below shows the variation in the enthalpy change of vaporisation of eight consecutive elements in Period 2 and 3 of the Periodic Table.

Which statement is correct?

A   Oxide of **Q** is basic.

B   Oxide of **V**, when dissolved in water, produces an acidic solution.

C   Chloride of **V**, when dissolved in water, produces a neutral solution.

D   Chloride of **W** when dissolved in water, produces an alkaline solution.

18 Barium sulfate occurs naturally as barite, which is a solid ore. Magnesium sulfate, however, occurs mainly in the solution.

Which statement best explains the above observation?

A   Barium ions are less readily hydrated than magnesium ions.

B   Barium sulfate has a stronger crystalline lattice.

C   Magnesium sulfate can react with water while barium sulfate cannot.

D   Barium sulfate is not as polar as magnesium sulfate, hence it is much less soluble in a polar solvent such as water.

19 In which reaction is chlorine gas formed?

    A $NaCl$ is heated strongly with I_2.

    B $NaCl$ is heated with concentrated H_2SO_4.

    C $NaCl$ is heated with $Na_2S_2O_3$.

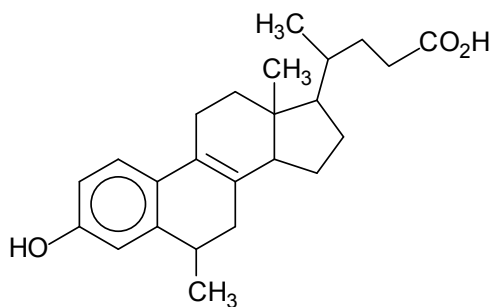   **D** $NaCl$ is heated with concentrated H_2SO_4 and MnO_2.

20 **X**(aq) undergoes the following reaction.
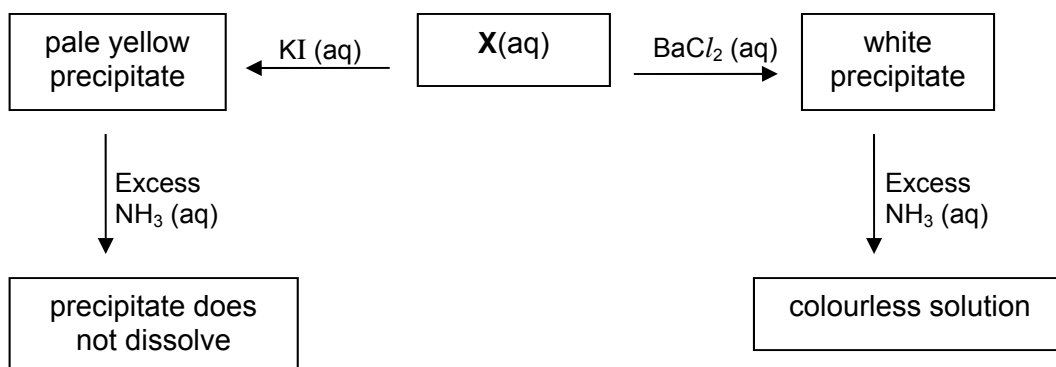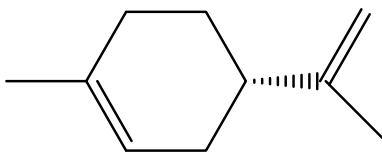

What is the identity of **X**?

    A $AgNO_3$ **B** Ag_2SO_4 **C** $Pb(NO_3)_2$ **D** $PbSO_4$

21 How many stereoisomers does this organic molecule have?

    A 2^4 **B** 2^5 **C** 2^6 **D** 2^7
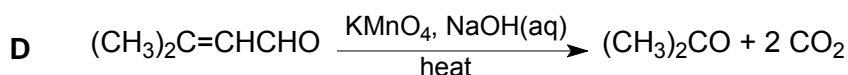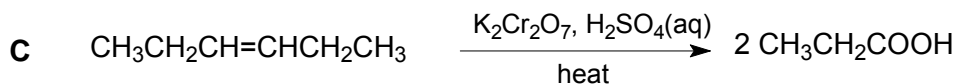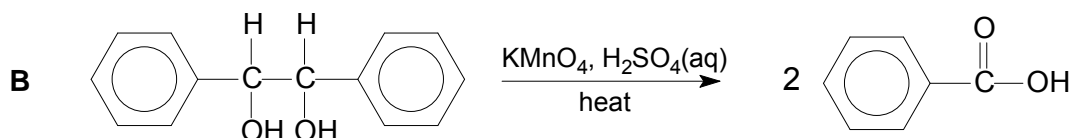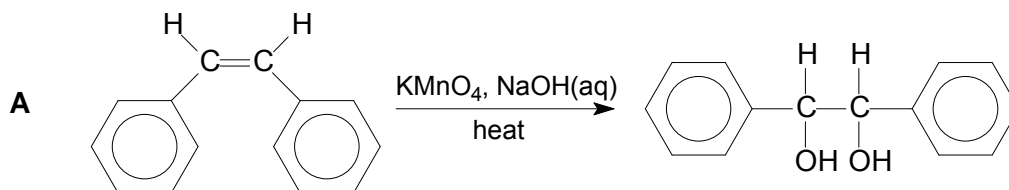
22 Limonene, a main odour constituent of citrus fruits, is added to cleaning products such as hand cleansers to give a lemon-orange fragrance.

Which statement about limonene is correct?

A It reacts with hot acidified concentrated $KMnO_4$ to give 2 organic compounds.

B The major product formed from the reaction of limonene with HBr(g) has chiral carbon(s).

C It reacts with H_2 in the presence of nickel to form an alkane with formula C_9H_{18}.

D It reacts with Br_2 in organic solvent to form a product with 4 chiral carbons.

23 The reaction conditions for four different transformations are given.

Which transformation has the correct conditions?

A

B

C $CH_3CH_2CH=CHCH_2CH_3$ $\xrightarrow[\text{heat}]{K_2Cr_2O_7,\ H_2SO_4(aq)}$ $2\ CH_3CH_2COOH$

D $(CH_3)_2C=CHCHO$ $\xrightarrow[\text{heat}]{KMnO_4,\ NaOH(aq)}$ $(CH_3)_2CO + 2\ CO_2$

24 Malic acid, $HO_2CCH(OH)CH_2CO_2H$, is found in apples.

Which statement about malic acid is **not** true?

A It can form esters with both ethanoyl chloride and ethanoic acid.

B 1 mole of malic acid can react with 3 moles of phosphorus(V) chloride.

C 1 mole of malic acid can react with 3 moles of hydrogen bromide gas.

D 1 mole of malic acid can react with 2 moles of sodium hydroxide.

25 Smoke from a bonfire contains a compound that causes irritation to the eyes. This compound readily decolourises aqueous bromine and produces a brick red precipitate with alkaline copper(II) tartrate. It also produces an insoluble product when reacted with acidified potassium dichromate(VI).

What is a possible structure of the compound?

A $CH_3CH_2CH_2OH$

B $CH_2=CHCHO$

C

CH=CH_2

CH_2CHO

D

CHO

OH
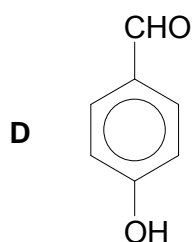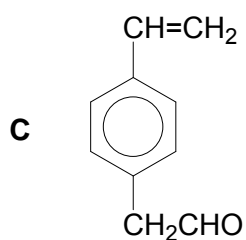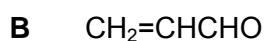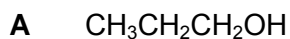
26 One industrial preparation of ethanoic acid is the direct carbonylation of methanol, using a rhodium catalyst.

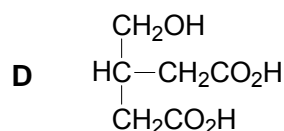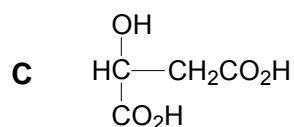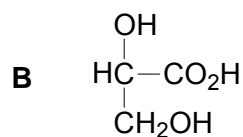$$CH_3OH + CO \xrightarrow[\text{catalyst}]{\text{Rhodium}} CH_3COOH$$
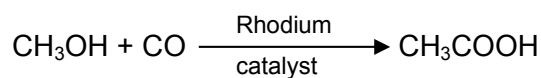
Which compound could be expected to produce
$$\underset{\displaystyle CH_2CO_2H}{\overset{\displaystyle CO_2H}{HC-CH_2CO_2H}}$$
by this method?

A
$$\underset{\displaystyle CH_2OH}{\overset{\displaystyle OH}{HC-CH_2CO_2H}}$$

B
$$\underset{\displaystyle CH_2OH}{\overset{\displaystyle OH}{HC-CO_2H}}$$

C
$$\underset{\displaystyle CO_2H}{\overset{\displaystyle OH}{HC-CH_2CO_2H}}$$

D
$$\underset{\displaystyle CH_2CO_2H}{\overset{\displaystyle CH_2OH}{HC-CH_2CO_2H}}$$
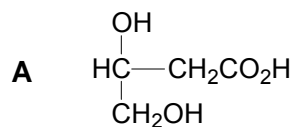
27 Butanone, $CH_3CH_2COCH_3$, may be used as the starting point for synthesising compound **Z**, $CH_3CH=C(CO_2H)CH_3$.

Which is the shortest possible process for producing **Z**?

A H_2, Pt → KCN, ethanol, heat → dil. H_2SO_4, reflux

B KCN, ethanol, heat → excess, c. H_2SO_4, heat → dil. H_2SO_4, reflux

C HCN, trace NaCN → Al_2O_3, heat → dil. H_2SO_4, reflux

D NaCN, H_2SO_4 → PCl_5 → NaOH, ethanol, heat → dil. H_2SO_4, reflux

28 Which statement about Paracetamol is correct?

$$H \quad CH_3$$
$$N-C=O$$

HO

Paracetamol
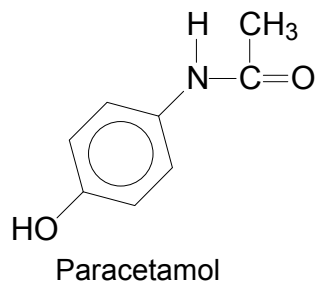
A It reacts with hot, aqueous sodium hydroxide to give sodium ethanoate.

B Yellow precipitate is observed upon addition of aqueous alkaline iodine.

C White fume is observed on addition of $SOCl_2$.

D It decolourises hot acidified $KMnO_4$.

29 The reaction below is carried out to synthesise an acid anhydride.

CH_3 → CH_3 $COCl$ → CO_2H CO_2H → (anhydride)
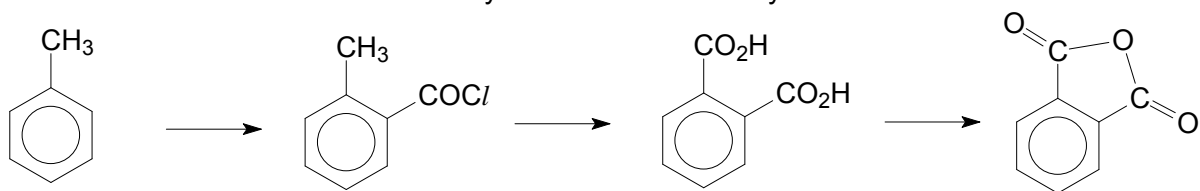
Which type of reaction is **not** involved in the above synthesis route?

A Condensation

B Elimination

C Hydrolysis

D Oxidation

30 Which pair shows the correct trend for pK_b value?

A $NH_3 > NH_2Cl$

B $C_6H_5CH_2NH_2 > CH_3CH_2NH_2$

C $CH_3NH_2 > C_6H_5NH_2$

D $CH_3CONH_2 > CH_3CH(OH)NH_2$

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 reactions/processes will result in a positive entropy change?

  1   Addition of 1 mole of Cl_2 (g) at 298K to 1 mole of N_2 (g) at 298K.

  2   Conversion of diamond to graphite.

  3   Combustion of ethane at room temperature and pressure.

32   The following shows the equilibrium reaction in the Contact process to form SO_3.

$$2SO_2(s) + O_2(g) \rightleftharpoons 2SO_3(g) \qquad \Delta H < 0$$

Which of the following correctly describes how the system will respond to the proposed change?

	change	value of K_c	partial pressure of $SO_3(g)$ at new equilibrium	forward rate constant, k_f
1	increase temperature	decrease	increase	increase
2	remove SO_3	no change	decrease	no change
3	add catalyst	no change	no change	increase

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 The position of equilibrium lies to the right in each of these reactions.

$$\textbf{Reaction 1}: N_2H_4 + HBr \rightleftharpoons N_2H_5^+ + Br^-$$

$$\textbf{Reaction 2}: N_2H_5^+ + NH_3 \rightleftharpoons NH_4^+ + N_2H_4$$
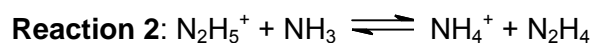
Based on this information, which statements are correct?

1 Br^- is the conjugate base of HBr.

2 $N_2H_5^+$ is the acid in **Reaction 2**.

3 The order of acid strength is $HBr > N_2H_5^+ > NH_4^+$.

34 This question is about sparingly soluble salts.

	AgCl	AgI	HgI$_2$
K_{sp}	1.0×10^{-10}	8.3×10^{-17}	1.1×10^{-28}

From the above information, which statements are true?

1 For a solution containing 1 mol dm^{-3} of NaCl and NaI, the concentration of iodide ions when AgCl just starts to precipitate is 8.3×10^{-7} mol dm^{-3}.

2 Solubility of HgI$_2$ is 3.02×10^{-10} mol dm^{-3}.

3 Solubility of HgI$_2$ increases when dilute nitric acid is added to it.

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.

35 The carbonates of Group II decompose according to the following equation.

$$MCO_3(s) \rightarrow MO(s) + CO_2(g)$$

For this reaction, ΔH increases on descending the group.

carbonate	Mg	Ca	Sr	Ba
ΔH/ kJ mol^{-1}	+101	+178	+235	+269

Which properties can be used to explain this trend?

1   The ionic radius of the metal ion.

2   The melting point of Group II metal carbonate.

3   Group II oxide is a stronger ionic lattice than Group II carbonate.

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

Which statements are correct?

1 CoF_3 reacts with H_2O to give O_2 gas.

2   Effervescence is observed when $Fe^{3+}(aq)$ is mixed with Na_2CO_3.

3 Na_2CrO_4 can be oxidised to $Na_2Cr_2O_7$.

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 A catalytic converter is part of the exhaust system of many modern cars.

Which reactions occur in a catalytic converter?

1    $2CO + 2NO \rightarrow 2CO_2 + N_2$

2    $CO_2 + NO \rightarrow CO + NO_2$

3    $2SO_2 + 2NO \rightarrow 2SO_3 + N_2$
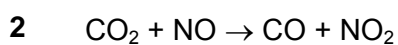
38 Compound **T** is reacted with excess NaOH(aq) under reflux while compound **V** is reacted with $NaBH_4$ in methanol.

Which pairs of **T** and **V** give the same product?

	T	V
1	$C_6H_5CH(Cl)CH_3$	$C_6H_5COCH_3$
2	$BrCH_2CH_2CH_2OH$	$CHOCH_2CO_2H$
3	$CH_3CH_2CH_2Cl$	$(CH_3)_2CO$

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

Quinone (cyclohexadiene–1,4–dione) can be formed by oxidising quinol (benzene–1,4–diol).

$$O=\text{(ring)}=O \ + 2\,H^+ + \ 2e^- \longrightarrow HO-\text{(ring)}-OH \qquad E^{\ominus} = +0.70 \text{ V}$$
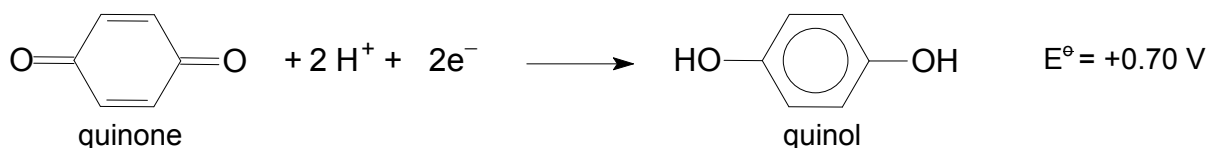
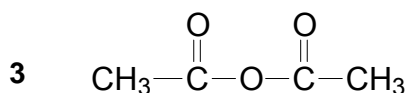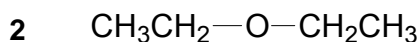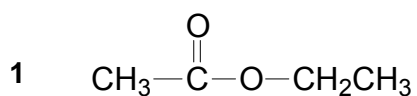quinone   quinol

Which statements are correct?

1 C bonded to O in quinone has an oxidation state of +2 while C bonded to O in quinol has an oxidation state of +1.

2 $E^{\ominus}_{cell}$ for the reaction between quinol and acidified $KMnO_4$ is positive.

3 $LiAlH_4$ can be used to reduce quinone to quinol.

40 In order to form a new bond between 2 reactant molecules containing hydroxyl groups, a dehydrating agent such as concentrated sulfuric acid can be used.

What are the possible products formed when ethanol reacts with ethanoic acid under reflux in the presence of concentrated sulfuric acid?

1
$$CH_3-\underset{\displaystyle \underset{}{\|}}{\overset{\displaystyle \overset{O}{\|}}{C}}-O-CH_2CH_3$$

2 $CH_3CH_2-O-CH_2CH_3$

3
$$CH_3-\overset{\displaystyle \overset{O}{\|}}{C}-O-\overset{\displaystyle \overset{O}{\|}}{C}-CH_3$$

– END OF PAPER –