ST ANDREW'S JUNIOR COLLEGE

JC2 Preliminary Examinations

Chemistry

Higher 2 — 9647/01

Paper 1 Multiple Choice — 22 September 2011

1 hour

Additional Materials: Multiple Choice Answer Sheet, Data Booklet

READ THESE INSTRUCTIONS FIRST

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

There are **40** questions on this paper. Answer all questions. For each question there are four possible answers A, B, C and D. Chose the one you consider correct and record your choice in soft pencil on the separate Answer Sheet.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer. Any rough working should be done in this booklet.

This document consists of **19** printed pages **in**cluding this page.

[Turn Over

Section A

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

1 A bottle of unknown hydrocarbon was found in a laboratory and had the following information on its label:

Boiling point / °C	63.0
Melting point/ °C	-139.8
Density / g cm^{-3}	0.673

When 25 cm^3 of this hydrocarbon was burned in excess oxygen, 28.8 dm^3 of gas was formed at room temperature and pressure. Which of the following could be the empirical formula for this hydrocarbon?

A CH_2

B CH_3

C C_5H_{12}

D C_6H_{12}

2 Sulfur compounds exist in multiple oxidation states. Which of the following options arranges compounds in increasing oxidation state of sulfur?

A SO_4^{2-}, SO_2, S, H_2S

B S, H_2S, SO_2, SO_4^{2-}

C S, SO_2, H_2S, SO_4^{2-}

D H_2S, S, SO_2, SO_4^{2-}

3 Which of the following is an isotope of oxygen?

A $^{16}_{9}O$

B $^{17}_{8}O$

C $^{17}_{9}O_2$

D $^{16}_{9}O_2$

4 In an experiment, the length of a hydrogen bond formed between HF molecules was measured to be 155 pm while that formed between H_2O molecules was 197 pm.

(1 pm = 10^{-12} m)

Which is **not** a possible explanation for the above observations?

A Oxygen is bigger than fluorine

B Fluorine is more electronegative than oxygen.

C The hydrogen bond between HF molecules is weaker than between H_2O molecules.

D The lone pair involved in hydrogen bonding in HF is in a smaller orbital compared to the lone pair involved in H_2O.

5 Which of the following compounds is planar?

A $C_6H_5CH_3$

B $[CuCl_4]^{2-}$

C C_6H_{14}

D O_3

6 Sodium ethanoate is used in food additives as it is safe to consume. Which of the following is most likely to be true for sodium ethanoate?

A It is more soluble in water than sodium chloride.

B It has a lower melting point than sodium chloride.

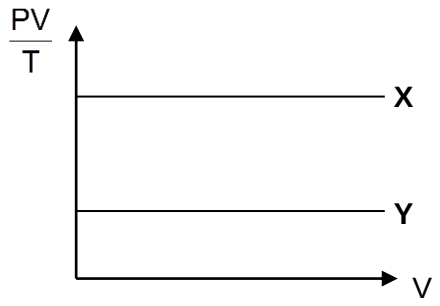
C A solution of sodium ethanoate is more acidic than a solution of sodium chloride.

D A solution of sodium ethanoate has a higher electrical conductivity than a solution of sodium chloride.

7 Which graph best represents the behaviour of an ideal gas at constant temperature, where the ratio of the number of moles of gas in containers **X** and **Y** are 3:1 respectively?

(ρ refers to the density of the gas)

A



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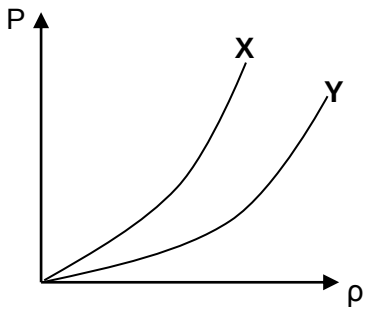

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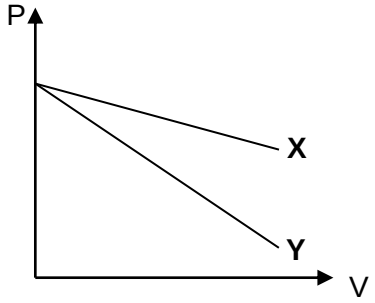

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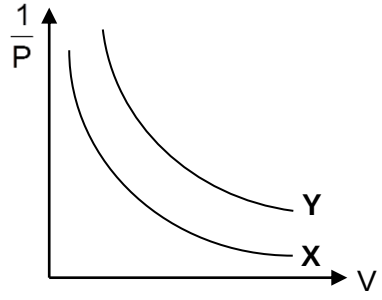


8 A student carried out an experiment to determine the enthalpy change of combustion of octane. The following data was collected.

Mass of water used / g	50.00
Initial temperature of water, T_i / ^oC	28.0
Max temperature of water, T_f / ^oC	34.0
Mass of spirit lamp and octane before combustion, $m_{initial}$ / g	44.52
Mass of spirit lamp and octane after combustion, m_{final} / g	44.00

Which of the following expression shows the calculation of the magnitude of the enthalpy change of combustion of octane?

A $$\Delta H_{combustion} = \frac{(44.52 - 44.00)\text{x}4.18\text{x}(34 - 28)}{40/114}$$

B $$\Delta H_{combustion} = \frac{44.52\text{x}4.18\text{x}(34 - 28)}{50}$$

C $$\Delta H_{combustion} = \frac{50\text{x}4.18\text{x}(307 - 301)}{(44.52 - 44.00)/114}$$

D $$\Delta H_{combustion} = \frac{50\text{x}4.18\text{x}(34 - 28)}{(44.52 - 44.00)}$$

9 Which of the following statements is ***incorrect***?

A The slow step for the reaction mechanism between bromoethane and aqueous sodium hydroxide involved the formation of an intermediate compound.

B The reaction between propanone and iodine can take place without the use of acid as catalyst.

C The reaction between ethene and hydrogen gas has relatively high activation energy.

D Dimerisation of NO_2 molecules into N_2O_4 is a fast reaction with low activation energy.

10 Consider the following reaction between nitrogen dioxide and carbon monoxide:

$NO_2(g) + CO(g) \longrightarrow NO(g) + CO_2(g)$

This reaction is carried out accordingly to the proposed mechanism:

Step 1	$2NO_2(g) \rightleftharpoons N_2(g) + 2O_2(g)$ [slow]
Step 2	**X** (g) + **Y** (g) $\rightleftharpoons$ **Z** (g) [fast]
Step 3	$N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$ [fast]

Which of the following are possible identities of **X**, **Y** and **Z**?

	X	**Y**	**Z**
A	2CO	2NO	O_2
B	2CO	NO	O_2
C	2CO	O_2	$2CO_2$
D	2CO	$2O_2$	CO_2

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

An antique pendant is to be chrome-plated. The pendant is dipped into a basic chromate (VI) solution where it serves as an electrode in an electrolytic cell. Oxygen is formed on the other electrode. Which one of the following statements is correct?

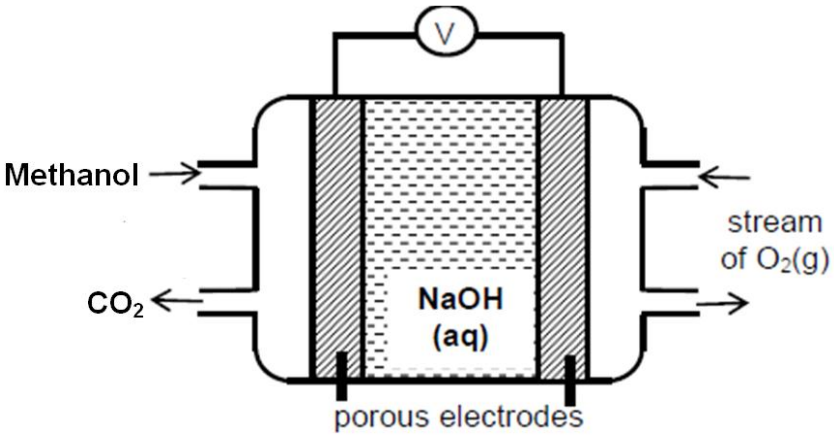
A Oxidation of water occurs to form oxygen.

B The pendant is the anode of the electrolytic cell.

C It takes about 16 hours to plate 52 g of chromium, if the current used is 1A.

D For every 104 g of chromium plated, 3 moles of oxygen gas is evolved.

12 Scientists are discovering that microbial fuel cell (MFC) technology is a viable alternative to power generation in remote locations. Powered only by water based organic waste such as methanol and the natural electrical generation processes by the bacteria, usable power for man can be harnessed, captured in batteries and utilized as necessary. An example of a MFC is as shown below.



Which of the following statements about the above MFC is ***incorrect***?

A Electrons flow from the right electrode to the left electrode.

B Methanol is oxidized in this reaction.

C The pH decreases at the anode.

D Porous electrodes are used to increase the rate of the reaction.

13 The standard redox potential for the half reaction

$$Hg^{2+} + e \rightleftharpoons Hg^{+} \text{ is } + 0.91V$$

Which cell would be used to determine this standard value?

A Pt electrode in a solution containing 1 mol dm^{-3} Hg^{2+} against Pt electrode in 1 mol dm^{-3} Hg^{+}.

B Hg electrode in a solution containing 1 mol dm^{-3} Hg^{2+} against Hg electrode in 1 mol dm^{-3} Hg^{+}.

C Pt electrode in a solution containing 1 mol dm^{-3} Hg^{2+} and 1 mol dm^{-3} Hg^{+} against a standard hydrogen electrode.

D Hg electrode in a solution containing 1 mol dm^{-3} Hg^{2+} and 1 mol dm^{-3} Hg^{+} against a standard hydrogen electrode.

14 When the gases dinitrogen tetroxide and nitrogen monoxide are mixed in a 1:2 ratio, the two gases slowly react to form the blue compound dinitrogen trioxide according to the following equilibrium.

$N_2O_4\,(g) + 2NO\,(g) \rightleftharpoons 2N_2O_3\,(g) \qquad \Delta H^{\theta} = -26\ kJmol^{-1}$

The forward and backward rate constants are given as k_1 and k_{-1} respectively. What happens to the equilibrium constant K_p, k_1, and k_{-1} if at equilibrium, the temperature of the reaction mixture is increased?

	k_1	k_{-1}	K_p
A	increases	increases	increases
B	unchanged	increases	unchanged
C	increases	increases	decreases
D	decreases	decreases	decreases

15 Calculate the pH of the resulting solution when 0.1 mole of aqueous nitric acid is added to a 1 dm^3 of solution containing 1.0 mol dm^{-3} of propanoic acid and 1.0 mol dm^{-3} of sodium propanoate.

(K_a propanoic acid = 1×10^{-5} mol dm^{-3})

A 5.08

B 5.00

C 4.91

D 4.00

16 The solubility product of a substance is **K**. If the concentration of the cation in a saturated solution is found to be $\left(\frac{8\mathbf{K}}{27}\right)^{\frac{1}{5}}$, which of the following is most likely to be the substance?

A $Cr(OH)_3$

B $Mg_3(PO_4)_2$

C $Ga_2(SO_4)_3$

D $PbBr_2$

17 Consider the following reactions :

$$4NH_3\,(g) + 5O_2\,(g) \rightarrow 4NO\,(g) + 6H_2O\,(l)$$

$$2NO\,(g) + O_2\,(g) \rightarrow 2NO_2\,(g)$$

$$3NO_2\,(g) + H_2O\,(l) \rightarrow 2HNO_3\,(aq) + NO\,(g)$$

$$4NH_3\,(g) + 6NO\,(g) \rightarrow 5N_2\,(g) + 6H_2O\,(l)$$

Which of the following has the strongest reducing ability?

A NH_3

B NO

C NO_2

D HNO_3

18 Cobalt (III) chloride forms a complex with ammonia in which the coordination number is 6. One mole of the compound formed reacts with 2 moles of silver nitrate.

Which of the following correctly shows the formula of this complex?

A $Co(NH_3)_3Cl_3$

B $Co(NH_3)_4Cl_3$

C $Co(NH_3)_5Cl_3$

D $Co(NH_3)_6Cl_3$

19 Which of the following is **not** true about Group II compounds?

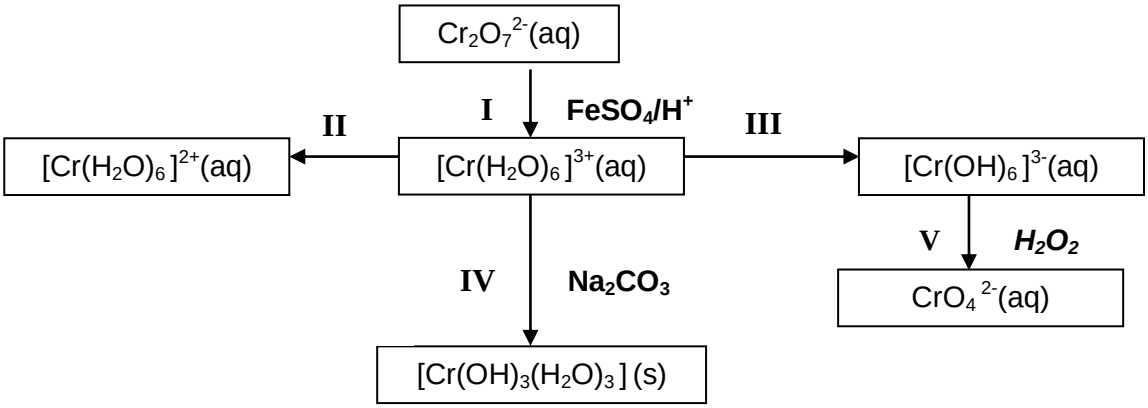
A Ionisation energy of Group II elements decreases down the group.

B Group II oxides react with bases to form salts and water.

C Reactivity of Group II oxides with water increases down the group.

D Lattice energy of Group II oxides becomes less exothermic down the group.

20 A reaction scheme involving chromium is shown below:



Which of the following statement is ***incorrect***?

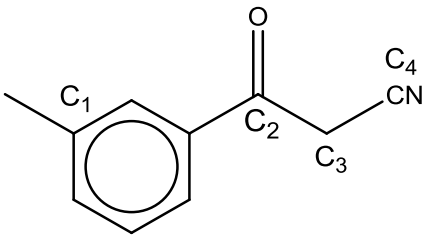
A The oxidation states of chromium shown in the above reaction scheme are +2, +3 and +6.

B Only step **IV** will produce both a precipitate and a gas.

C Steps **I**, **II** and **IV** will produce a colour change.

D Steps **III** and **IV** will involve a change in the oxidation state of chromium.

21 What is the hybridisation of the various carbon atoms in the following molecule?



	C_1	C_2	C_3	C_4
A	sp^2	sp^3	sp	sp^2
B	sp^2	sp^2	sp^3	sp
C	sp^2	sp^2	sp	sp^3
D	sp^3	sp^2	sp^3	sp

22 For the reaction of propene with aqueous bromine in the presence of sodium chloride, which of the following species is **not** a possible product of the reaction?

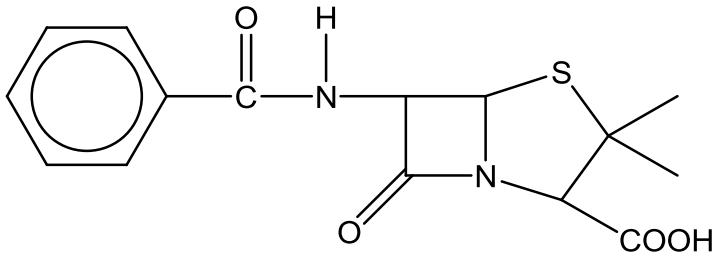
A $CH_3CHBrCH_2Br$

B $CH_3CHBrCH_2OH$

C $CH_3CHNaCH_2Br$

D $CH_3CHClCH_2Br$

23 Penicillin is widely used to kill bacteria. The structure of a penicillin molecule is shown below.



Which of the following type of reactions will **not** take place with a molecule of penicillin?

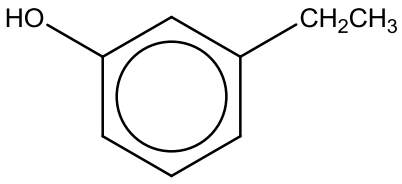
A Reduction

B Hydrolysis

C Nucleophilic addition

D Electrophilic substitution

24 Which of the following reagent should **not** be used to distinguish the following two compounds?



and $CH_3CH=C(CH_3)CH_2OH$

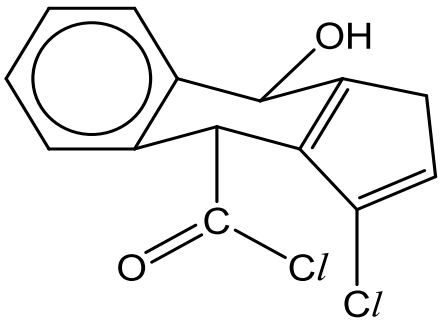
A Hot acidified $KMnO_4$

B Br_2 (aq)

C HBr

D NaOH (aq)

25 Which of the following reagents will give a positive test with the compound below?



A 2,4-dinitrophenylhydrazine

B Ethanolic KCN

C Concentrated H_2SO_4

D H_2O

26 Compound **X** is neutral and water soluble. **X** does not react with Fehling's solution but gives a yellow precipitate with hot alkaline iodine. Which of the following is a possible structure for Compound **X**?

A $CH_2OHCH_2CH_2OH$

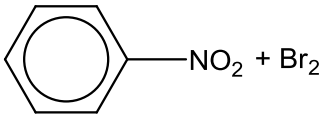
B $CH_3CH(OH)COOH$

C $CH_3CH(OH)CHO$

D CH_3COCH_2OH

27 Which of the following will give an immediate precipitate when aqueous silver nitrate is added to the resultant solutions of the following reactions?

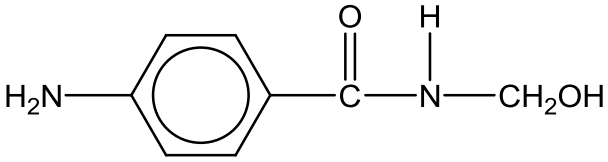
A $CH_3COCH_2CH_3$ + alkaline aqueous I_2

B 

C $CH_3CH_2OH + PBr_3$

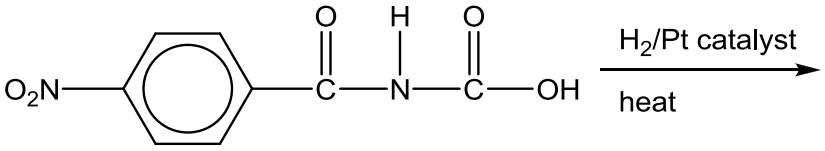
D $CH_3CH_2CH=CH_2 + I_2$

28 The following compound is synthesised in the laboratory.

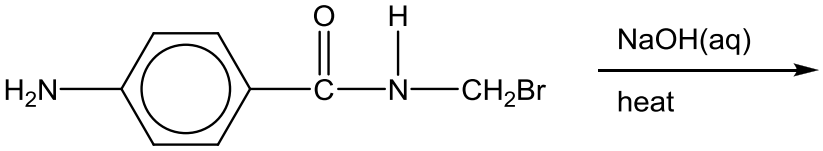


Which of the following is a possible means of preparation?

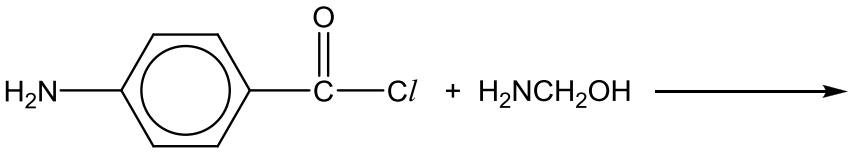
A



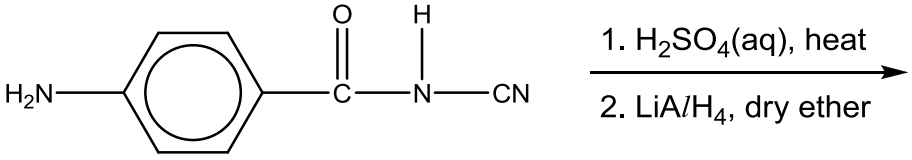
B



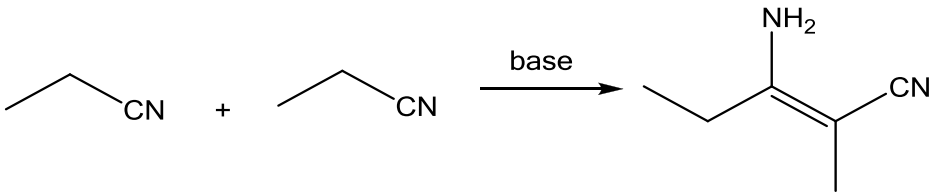
C



D



29 The Thorpe reaction is a self condensation of aliphatic nitriles in the presence of a base catalyst. The self condensation between two molecules of propanenitrile is shown below.



Which of the following can be synthesized by the Thorpe reaction?

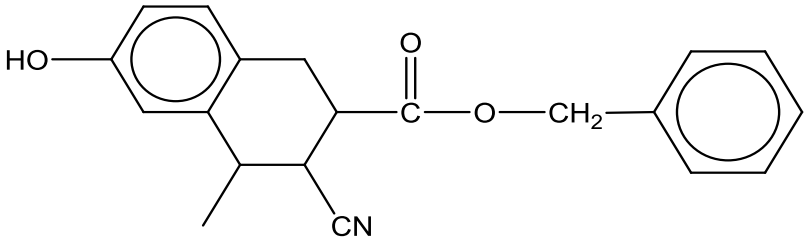
A $CH_3C(NH_2)=C(CH_3)CN$

B $CH_3CH_2C(NH_2)=C(CH_2CH_3)CN$

C $CH_3CH_2CH_2C(NH_2)=C(CH_2CH_3)CN$

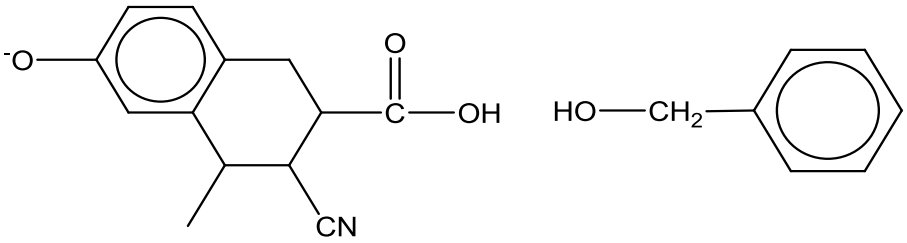
D $CH_3CH_2CH_2C(NH_2)=C(CH_2CH_2CH_3)CN$

30

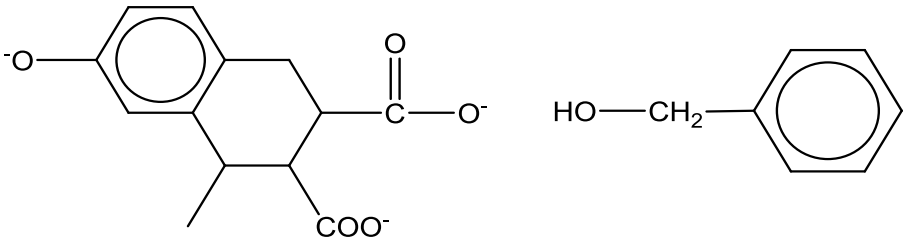


What are the likely organic products from the reaction of the above compound with an excess of boiling aqueous NaOH?

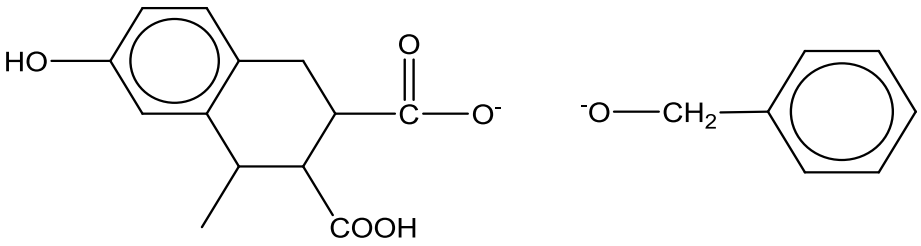
A



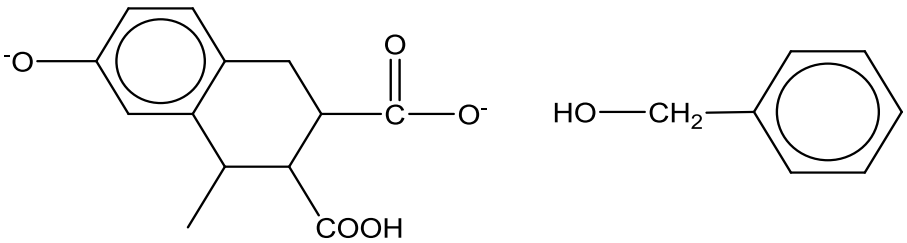
B



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 useful 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.

31 Which reactions between the following pairs of reagents do not involve oxidation and reduction?

1 Concentrated sodium hydroxide and phenol

2 Sodium borohydride and ethanol

3 Carbon monoxide and oxygen

32 Ethane and ethene are two commonly used hydrocarbons in the world today. Which of the following statements are correct about ethane and ethene?

1 The C-H bond of ethene is stronger than the C-H bond in ethane.

2 The C-C bond length in ethene is shorter than that in ethane.

3 Ethane and ethene have at least 6 σ bonds each.

33 Consider the following reaction of potassium chloride:

$$KCl(s) \longrightarrow KCl(aq) \quad , \Delta H_{rxn} = \boldsymbol{x} \text{ kJ mol}^{-1}$$

Which of the following information are needed in the calculation for the enthalpy change of reaction, ***x***?

1 The sum of the enthalpy of hydration of K^+ (g) and Cl^- (g)

2 Lattice energy of KC*l* (s)

3 The sum of the enthalpy change of first ionisation energy of K (g) and the first electron affinity of C*l* (g).

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.

34 Which of the following sets show that the first substance has *greater* standard molar entropy (S^{θ}) than the second substance?

1 HBr (g), HF (g)

2 C_2H_6 (g), C_2H_4 (g)

3 NaC*l* (aq), A*lCl*$_3$ (aq)

35 The table below shows the reduction potential values for some compounds of chlorine.

Half-reaction	E^{θ} (V)
$8H^+ + ClO_4^- + 7e \rightleftharpoons \frac{1}{2}Cl_2 + 4H_2O$	+1.42
$\frac{1}{2}Cl_2 + e \rightleftharpoons Cl^-$	+1.36
$ClO^- + H_2O + 2e \rightleftharpoons Cl^- + 2OH^-$	+0.89
$ClO_3^- + 3H_2O + 6e \rightleftharpoons Cl^- + 6OH^-$	+0.63
$ClO_4^- + 4H_2O + 8e \rightleftharpoons Cl^- + 8OH^-$	+0.56

Using these data, which one of the following are ***incorrect***?

1 Aqueous chlorine undergoes disproportionation spontaneously.

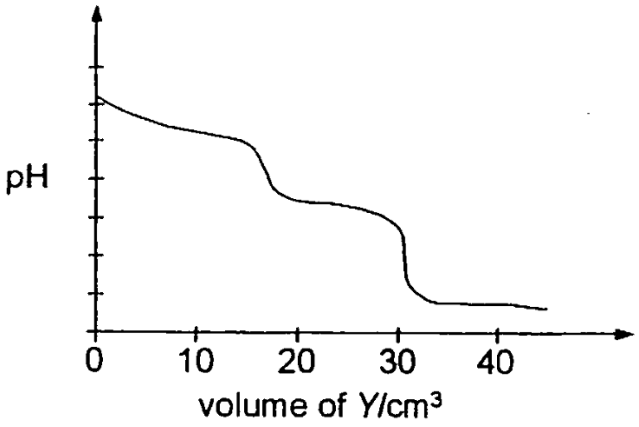
2 Chlorate (VII) is a **weaker** oxidising agent than chlorate (V).

3 Chlorate (I) and chlorine gas react together to form chloride ions.

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.

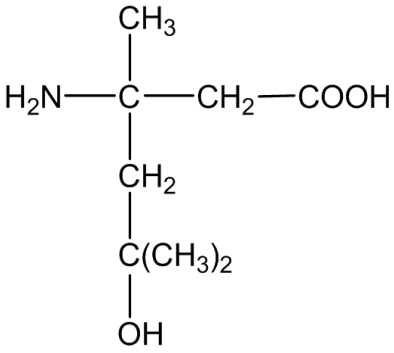
36 The diagram below shows the change of pH produced by gradually adding aqueous **Y** to a certain volume of aqueous **X**. The concentration of **X** and **Y** are both 0.1 mol dm^{-3}.



Which of the following could be possible solutions of **X** and **Y**?

	X	Y
1	Na_2CO_3	H_2SO_4
2	$(CH_2NH_2)_2$	H_3PO_4
3	$NaHCO_3^-$	HNO_3

37 The following is the molecular structure of a β-amino acid. It is usually found in an aqueous state at room temperature.



Which of the following statements of the β-amino acid are true?

1 It forms a giant ionic structure.

2 It will react with 2 moles of sodium hydroxide.

3 It cannot rotate the plane of polarised light.

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.

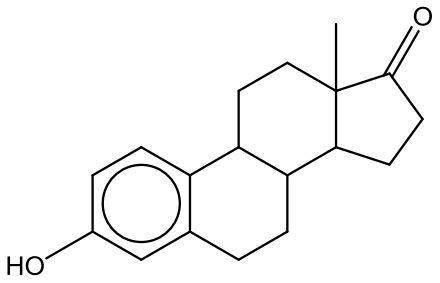
38 Which of the following pairs will give the same organic product when treated with hot acidified $KMnO_4$?

1 $(COOH)_2$ and $CH_2=CH_2$

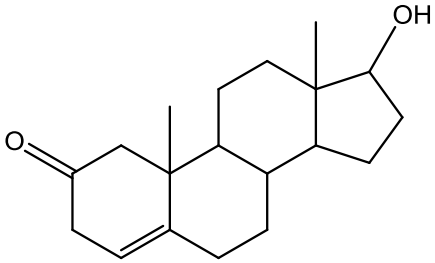
2 $CH_3CH=CHCH_3$ and CH_3CH_2OH

3 $C_6H_5CH_2CH_2OH$ and $C_6H_5CH=CH_2$

39 Compounds **A** and **B** are both hormones found in the human body. They have the following structures.



A



B

Which of the following statements about the two compounds are true?

1 Both decolourises Br_2

2 Both will react with hot acidified $KMnO_4$.

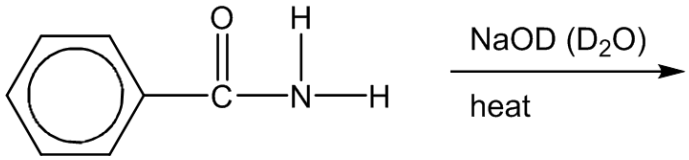
3 Both have 5 chiral carbons each.

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

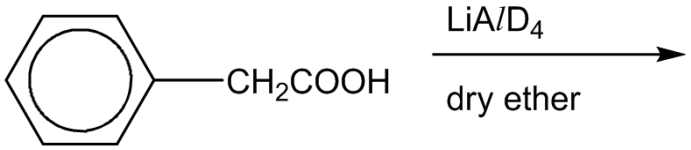
A	B	C	D
1, **2** and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct.

40 Which of the following will yield an organic compound containing deuterium? (D=^{2}H)

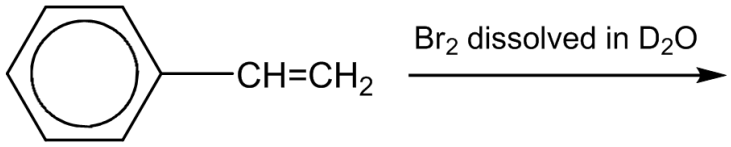
1



2



3



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