NATIONAL JUNIOR COLLEGE
SH2 PRELIMINARY EXAM
Higher 2

CANDIDATE NAME

SUBJECT CLASS

REGISTRATION NUMBER

CHEMISTRY **9647/01**

Paper 1 Multiple Choice

Additional Materials: Multiple Choice Answer Sheet
Data Booklet

Fri 21 Sept 2012
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 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 atom has the highest ratio of unpaired electrons to paired electrons in its ground state?

A boron

B carbon

C nitrogen

D oxygen

2 Bombardment of ^{14}N with a-particles (helium nuclei) produces a hydrogen nucleus and another nucleus. This other nucleus is

A $^{14}C_6$

B $^{14}N_7$

C $^{17}O_8$

D $^{18}Ne_{10}$

3 The successive ionisation energies (kJ mol^{-1}) of two elements are given below:

X	1012	1907	2914	4964	6274	21267	26431	29876	35905
Y	1251	2298	3822	5159	6542	9362	11108	33604	38860

Which of the following statements is **false**?

A The formula of the compound formed between X and Y is XY_3.

B The compound formed between X and Y is covalent.

C X has a giant covalent structure.

D Y exists as diatomic molecules.

4 When the N_2^+ ion is formed from N_2, a σ bonding electron is removed.
Which statement is correct?

A The bond order decreases so N_2^+ has a stronger, shorter bond than N_2.

B The bond order decreases so N_2^+ has a weaker, longer bond than N_2.

C The bond order increases so N_2^+ has a stronger, shorter bond than N_2.

D The bond order increases so N_2^+ has a weaker, longer bond than N_2.

5 In which pair of species are the values of the bond angles the closest?

A BF_3 and NH_3

B CH_3^- and BF_3

C H_2O and C_2H_4

D NH_4^+ and SO_4^{2-}

6 10 cm^3 of hydrocarbon is burnt in 100 cm^3 of excess oxygen at room temperature. The final volume of gas mixture is 85 cm^3. When the gas mixture is bubbled through aqueous sodium hydroxide solution, the volume of gas mixture decreases to 55 cm^3. What is the formula of the hydrocarbon?

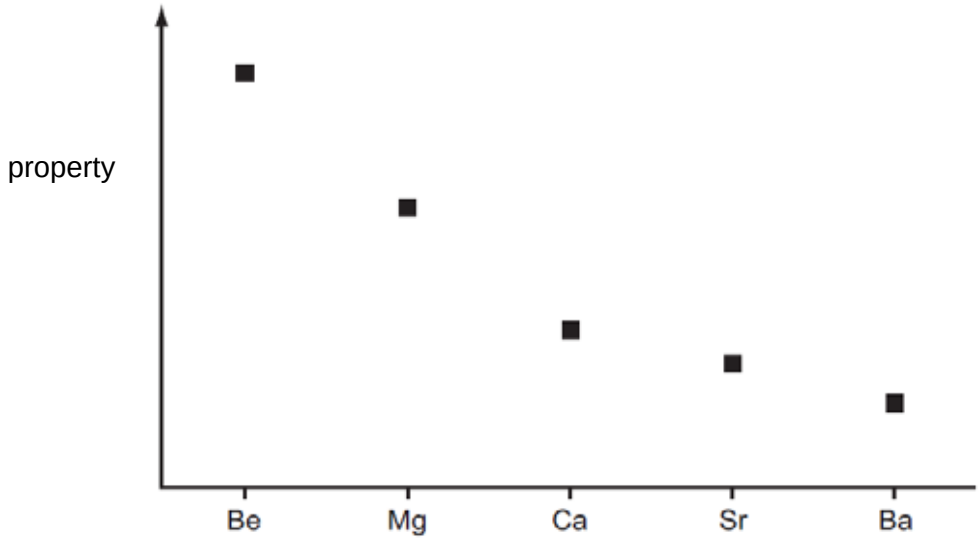
A C_3H_6

B C_3H_8

C C_6H_{12}

D C_6H_{14}

7 *Use of the Data Booklet is relevant to this question*.
The graph represents the variation of a property of the Group II elements.



What is this property?

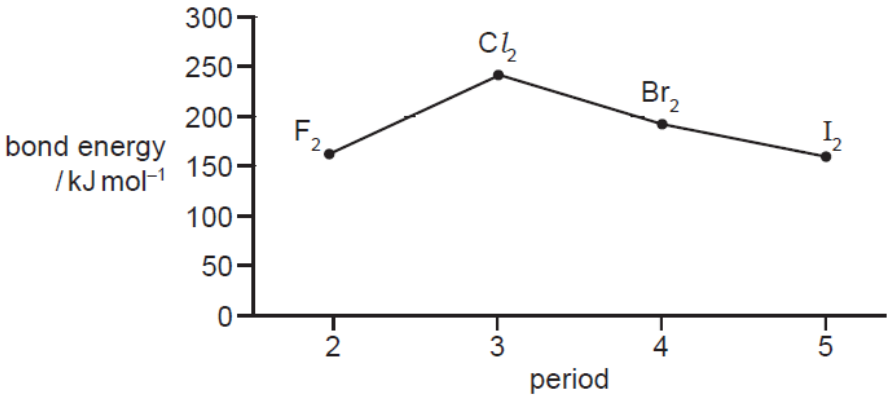
A ionic radius

B ionisation energy

C neutron / proton ratio

D rate of reaction with water

8 The diagram shows bond energies in halogen molecules.



Why does the value for fluorine **not** follow the trend shown by chlorine, bromine and iodine?

A Fluorine is more electronegative than the other halogens.

B Lone electron pairs in fluorine repel more strongly than those in the other halogens.

C The bonds in fluorine are more polar than those in the other halogens.

D The bonds in fluorine have some π-character.

9 What is the pressure (in Pa) of a sample of hydrogen gas that has density of 8 gm^{-3} at 300 °C?

A $\frac{573 \times 4 \times 22.4 \times 101 \times 10^3}{273}$

B $\frac{573 \times 8 \times 22.4 \times 101}{273}$

C $\frac{273 \times 4 \times 11.2 \times 101 \times 10^3}{573}$

D $\frac{573 \times 8 \times 11.2 \times 101}{273}$

10 The rate equation for the reaction

$$S_2O_8^{2-}(aq) + 2\,I^-(aq) \rightarrow 2SO_4^{2-}(aq) + I_2(aq)$$

is rate = $k[S_2O_8^{2-}][I^-]$ where k, the rate constant is found to be 0.2 $mol^{-1}\ dm^3\ s^{-1}$ at temperature t.

What is the half-life of the reaction when $S_2O_8^{2-}$ is present in a large excess at a concentration of 0.5 mol dm^{-3} at the same temperature t?

A 0.7 s

B 1.4 s

C 3.5 s

D 6.9 s

11 Hess's Law can be used to calculate the average C–H bond energy in methane.

$\Delta H^{\ominus}_{at}$ = standard enthalpy change of atomisation
$\Delta H^{\ominus}_{f}$ = standard enthalpy change of formation
$\Delta H^{\ominus}_{c}$ = standard enthalpy change of combustion

Which values of the following data are needed in order to perform the calculation?

A $\Delta H^{\ominus}_{c}(C)$, $\Delta H^{\ominus}_{c}(H_2)$, $\Delta H^{\ominus}_{c}(CH_4)$

B $\Delta H^{\ominus}_{at}(C)$, $\Delta H^{\ominus}_{at}(H_2)$, $\Delta H^{\ominus}_{f}(CH_4)$

C $\Delta H^{\ominus}_{c}(C)$, $\Delta H^{\ominus}_{c}(H_2)$, $\Delta H^{\ominus}_{f}(CH_4)$

D $\Delta H^{\ominus}_{f}(CH_4)$ only as $\Delta H^{\ominus}_{f}(C)$ and $\Delta H^{\ominus}_{f}(H_2)$ are defined as zero.

12 In a car engine, non-metallic element **X** forms a pollutant oxide **Y**.
Further oxidation of **Y** to **Z** occurs spontaneously in the atmosphere. In this further oxidation, 2 mol of **Y** reacts with 1 mol of gaseous oxygen. **Z** can dimerise at specific conditions.
Which statement about **X**, **Y** and **Z** is **incorrect**?

A **X** forms a basic hydride.

B **Y** is a diatomic molecule.

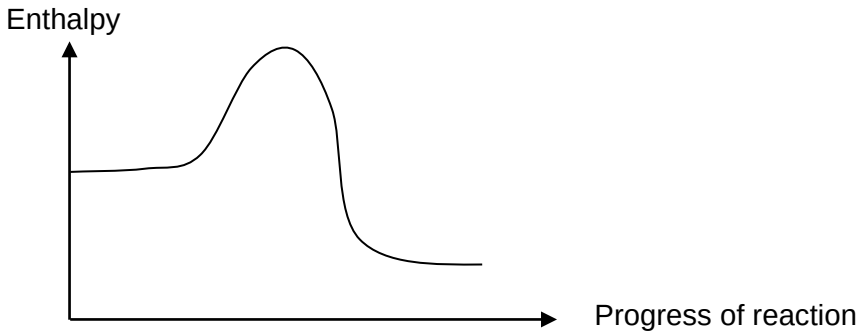
C **Z** is a polar molecule.

D **Z** contributes to global warming.

13 The diagram below represents the reaction profile of the monomer-dimer system:

$$2NO_2\ (g) \underset{k_b}{\overset{k_f}{\rightleftharpoons}} N_2O_4\ (g)$$

brown colourless



Which statement about the equilibrium is correct?

A The equilibrium constant K_c will be larger at higher temperatures.

B k_f increases and k_b decreases when the equilibrium mixture is heated.

C Doubling the total pressure of the system reduces the percentage dissociation to half.

D At higher temperature, the colour intensity of the mixture increases.

14 Which of the following statements about the spontaneity of the gas-phase reaction shown is true at 25 °C?

$$2\ O{=}N{-}Cl(g) \rightarrow 2\ N{=}O(g) + Cl_2(g)$$

A The reaction cannot be spontaneous.

B The reaction will be spontaneous regardless of the magnitude of ΔH and ΔS.

C The reaction will be spontaneous only if the magnitude of ΔH is large enough to overcome the unfavorable entropy change.

D The reaction will be spontaneous only if the magnitude of ΔS is large enough to overcome the unfavorable enthalpy change.

15 When a mineral was heated in a Bunsen flame to constant mass, a colourless gas that turned limewater milky was evolved. The remaining solid was cooled and then added to aqueous hydrochloric acid. Vigorous effervescence was seen.

What was the mineral?

A Dolomite, $CaCO_3.MgCO_3$

B Barytocalcite, $BaCO_3.CaCO_3$

C Aragonite, $CaCO_3$

D Artinite, $MgCO_3.Mg(OH)_2.3H_2O$

16 The following two experiments are carried out with anhydrous potassium chloride and observations **X** and **Y** are made at the end of each experiment.

Concentrated sulfuric acid is added to the potassium chloride and the fumes produced are bubbled into aqueous potassium iodide solution - observation **X**.

The potassium chloride is dissolved in aqueous ammonia and this is then added to aqueous silver nitrate - observation **Y**.

What are the observations **X** and **Y**?

	X	**Y**
A	Brown solution	Colourless solution
B	Brown solution	White precipitate
C	Colourless solution	Colourless solution
D	Colourless solution	White precipitate

17 The unbalanced equation below involves manganese species in acid medium.

$$MnO_4^{2-} \longrightarrow Mn^{2+} + MnO_4^-$$

Which of the following statements is **false**?

A This is a disproportionation reaction.

B MnO_4^- ions are purple due to the presence of d–d electronic transition.

C Unequal amounts of Mn^{2+} and MnO_4^- ions are formed.

D The 3d electrons in Mn^{2+} ions are unpaired.

18 The oxide and chloride of an element **X** are separately mixed with water. The two resulting solutions have the same effect on litmus.
What is element **X**?

A Sodium

B Magnesium

C Aluminum

D Phosphorus

19 Under similar conditions, carbon monoxide competes 200 times more effectively than oxygen for haemoglobin available in blood. The effects in the body of carboxyhaemoglobin are detectable when it reaches 5 % of the concentration of oxyhaemoglobin in the blood. Air contains 20 % of oxygen by volume.

By using these data, it can be deduced that the minimum concentration (parts per million, ppm) of carbon monoxide in the atmosphere that will result in detectable effects in the body is

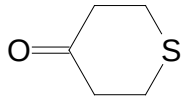
A 10 ppm

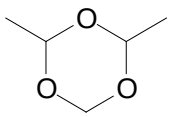
B 50 ppm

C 250 ppm

D 500 ppm

20 Which of the following compounds is **not** made up of 6.90 % and 51.7% by mass of hydrogen and carbon respectively?

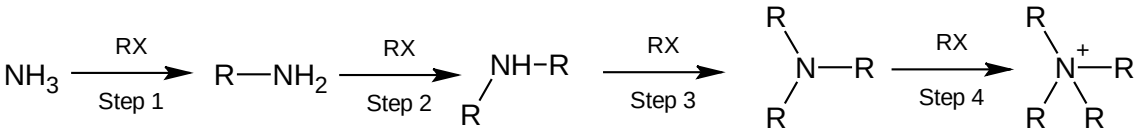
A 

B 

C $CH_3CSCH(CH_3)CHO$

D $CH_3CO(CH_2)_2CO_2H$

21 A halogenoalkane is reacted with NH_3 in the following reaction.
Which of the statements is correct?



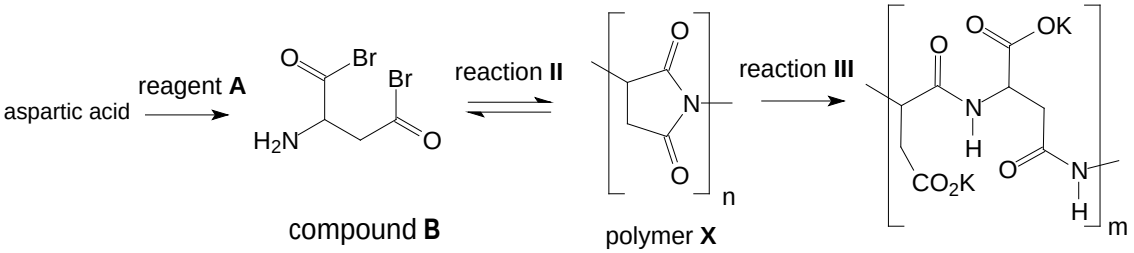
A Rate of reaction of step 2 is faster than step 3 as RNH_2 is a stronger nucleophile.

B Rate of reaction of step 3 is faster than step 2 as RNH_2 is a stronger nucleophile.

C R_4N^+ will be the major product when excess RX is used.

D R_4N^+ will be the major product when excess NH_3 is used.

22 Aspartic acid, $HO_2CCH_2CH(NH_2)CO_2H$, is an essential amino acid. Its anion, aspartate is an important metabolite in the urea cycle. Aspartic acid can be used to make polymers.



Which of the following statements is true?

A A white precipitate is formed when aqueous silver nitrate is added to compound **B**.

B Reagent **A** is aqueous thionyl bromide.

C One mole of hot aqueous KOH is required to react with one mole of polymer **X** in reaction **III**.

D The imide (the –CONRCO- group present in the polymer **X**) has a higher pK_b value than an average amide.

23 Which of the following gives the compounds in order of decreasing K_a?

A CH_3CH_2OH > C_6H_5OH > CH_3CO_2H

B $CH_3CF_2CO_2H$ > FCH_2CHFCO_2H > $F_2CHCH_2CO_2H$

C $CH_3CH_2CO_2H$ > $CH_2(OH)CH_2COOH$ > $CH_3CH(OH)CO_2H$

D $CH_3CH_2CO_2H$ > $CH_3CH(OH)CO_2H$ > $CH_2(OH)CH_2COOH$

24 A chloroalkane **G** with molecular formula $C_5H_{11}Cl$ exhibits optical activity. On warming **G** with alcoholic NaOH, two alkenes **E** and **F** are formed, **E** being the major product. One of the products of the reaction between **E** and hot acidified potassium manganate(VII) gives a yellow precipitate with alkaline aqueous iodine.

Which of the following could be **G**?

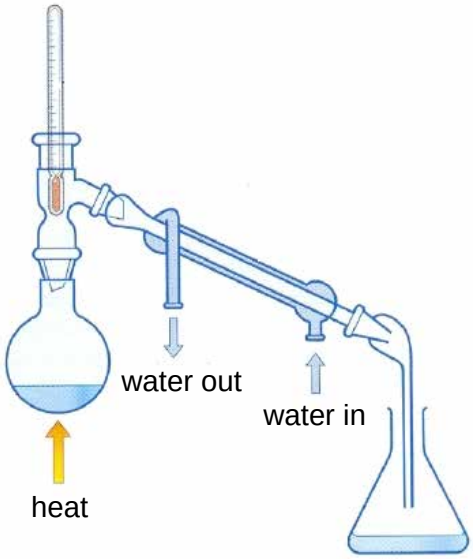
A $CH_3CHClCH_2CH_2CH_3$

B $CH_3CH_2CHClCH_2CH_3$

C $CH_3CH(CH_3)CHClCH_3$

D $CH_3CCl(CH_3)CH_2CH_3$

25 Which of the following compounds can be prepared by the apparatus shown?



A 1,2-dibromoethane by using bromine and ethene.

B Ethanoic acid by using ethanol, sodium dichromate(VI) and sulfuric acid.

C Bromoethane by using ethanol, sodium bromide and concentrated sulfuric acid.

D Phenyl ethanoate by using phenol and ethanoyl chloride.

26 It has been estimated that for every atom of chlorine or bromine generated from a halogenoalkane in the stratosphere, one hundred thousand molecules of ozone may be destroyed.

Which of the following organic compounds is most destructive to ozone?

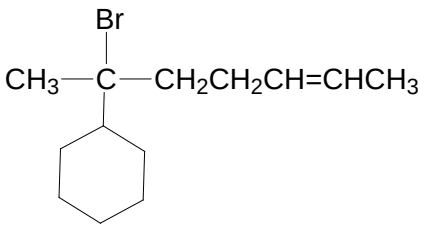
A $CF_2Cl CH_2CF_2Cl$

B CCl_2BrCH_2Br

C $CHCl_2CBr_3$

D CCl_4

27 What is the total number of stereoisomers that can be obtained from the major product of the reaction between compound **H** and NaOH in ethanol?



compound **H**

A 2

B 4

C 8

D 12

28 When a nonapeptide (containing nine amino acid residues) isolated from rat brains was hydrolysed, it gave the following smaller peptides as identifiable products:

Gly-Ala-Phe
Ala-Leu-Val
Gly-Ala-Leu
Phe-Glu-His
His-Gly-Ala

What is the amino acid sequence in the nonapeptide?

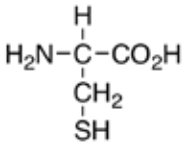
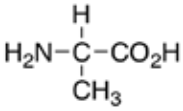
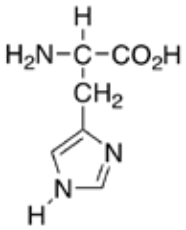
A Gly-Ala-Leu-Val-Phe-Glu-His-Gly-Ala

B Phe-Glu-His-Gly-Ala-Leu-Val-Gly-Ala

C Gly-Ala-Phe-Glu-His-Gly-Ala-Leu-Val

D His-Gly-Ala-Phe-Glu-His-Leu-Val-Gly

29 A tripeptide, cys-ala-his, was analysed using electrophoresis. The tripeptide was hydrolysed and the resulting solution was then placed at the centre of the plate in a buffer solution of pH 6.5. A potential difference was then applied across the plate.

Amino acid	 cysteine (cys)	 alanine (ala)	 histidine (his)
Isoelectric point	5.05	6.00	7.60

With reference to the above table, which of the following statements is correct?

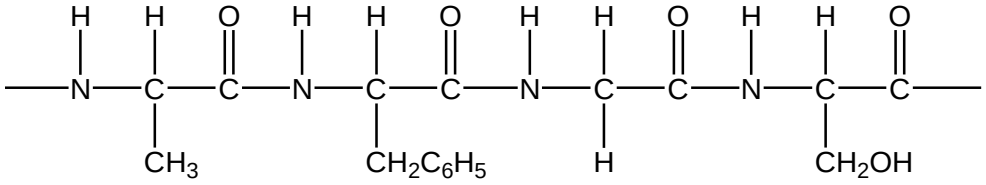
A Alanine would remain at the centre of the plate.

B Cysteine would migrate towards the cathode.

C Histidine would migrate towards the anode.

D Alanine would migrate towards anode.

30 The sequence below is the repeat unit of a polypeptide chain in egg albumin.



Which of the following will cause this part of the protein to coagulate?

I. Addition of $Pb(NO_3)_2(aq)$
II. Heating in a frying pan
III. Addition of $H_2SO_4(aq)$
IV. Whisking with an egg beater

A II and IV only

B I, II and III only

C II, III and IV only

D I, II, III and IV

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 The table below gives the percentage of HX dissociated into H_2 and X_2 at different temperatures.

Temperature/ ^oC	HF	HC*l*	HBr	HI
200	-	-	-	13
600	-	-	4×10^{-2}	22
2000	6×10^{-5}	4×10^{-1}	4	30

Which of the following statements explain the data given?

1 The polarity of the H–X bond becomes weaker on going down the group.

2 The s-p overlap in the H–X bond is less efficient on going down the group.

3 The dissociation of HX is an endothermic reaction.

32 All the statements below are true.

Which of these can be explained, at least in part, by reference to hydrogen bonding?

1 Ice floats on water.

2 The boiling point of propan-2-ol is 82 °C. The boiling point of propanone is 56 °C.

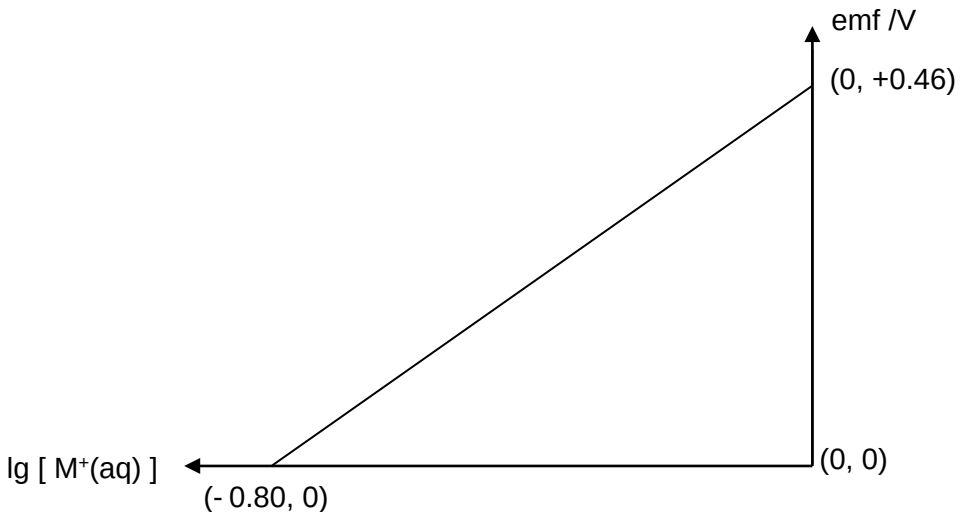
3 At a specific temperature, the apparent relative molecular mass of ethanoic acid is 90.

33 In which of the following does statement **II** give a correct explanation for statement **I**?

	Statement **I**	Statement **II**
1	Ethanamide, CH_3CONH_2 is a weaker base than methylamine, CH_3NH_2.	The electronegativity of the oxygen atom of the carbonyl group reduces the availability of the lone pair of electrons on the nitrogen atom in ethanamide.
2	The boiling point of ethanol is higher than that of ethanethiol, C_2H_5SH.	The ethanethiol molecule has a larger electron cloud than ethanol.
3	The ionic product of water, K_w increases with increasing temperature.	$H^+(aq)$ and $OH^-(aq)$ ions react exothermically.

34 *Use of the Data Booklet is relevant to this question.*
The graph below shows the variation in electromotive force (emf) of the electrochemical cell with lg [$M^+(aq)$] at 298 K.

$$Cu(s) \mid Cu^{2+}(aq, 1\ mol\ dm^{-3}) \parallel M^+(aq) \mid M(s)$$



Which of the following statements are true?

1 The $Cu^{2+}(aq)\,|\,Cu(s)$ half cell is the negative pole.

2 The emf of the given cell under standard conditions will be +0.46V.

3 The standard electrode potential of the half cell $M^+(aq) \mid M(s)$ is +0.80V.

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 following two equations show two different partial ligand substitution reactions of the hexaaquacopper(II) ion. (en represents 1,2-diaminoethane, $H_2NCH_2CH_2NH_2$)

I: $[Cu(H_2O)_6]^{2+}(aq) + en(aq) \rightarrow [Cu(en)(H_2O)_4]^{2+}(aq) + 2H_2O(l)$ $\Delta H = -54\ kJ\ mol^{-1}$

II: $[Cu(H_2O)_6]^{2+}(aq) + 2NH_3(aq) \rightarrow [Cu(NH_3)_2(H_2O)_4]^{2+}(aq) + 2H_2O(l)$ $\Delta H = -46\ kJ\ mol^{-1}$

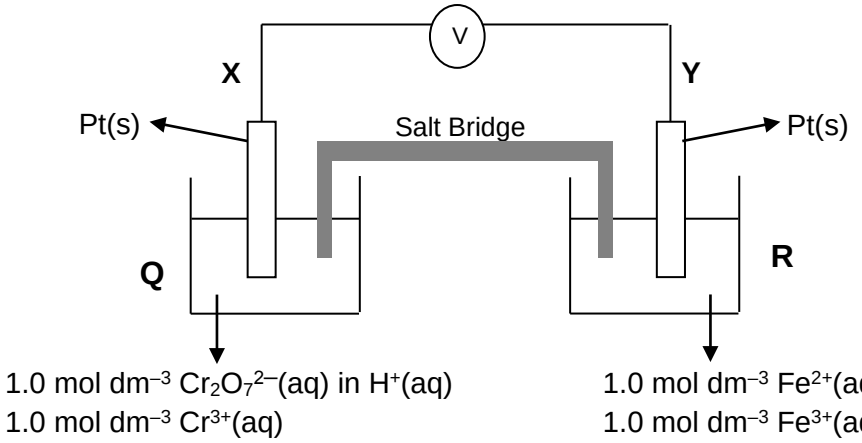
Which of the following statements are correct?

1 The entropy change, ΔS^{θ}, for reaction I is more positive than that for reaction II.

2 The stability constant of $[Cu(en)(H_2O)_4]^{2+}$ is larger than that of $[Cu(NH_3)_2(H_2O)_4]^{2+}$.

3 The cation formed in reaction II exhibits geometric isomerism.

36 *Use of the Data Booklet is relevant to this question.*
The cell shown in the diagram below is set up under standard conditions.



Which of the following statements are correct?

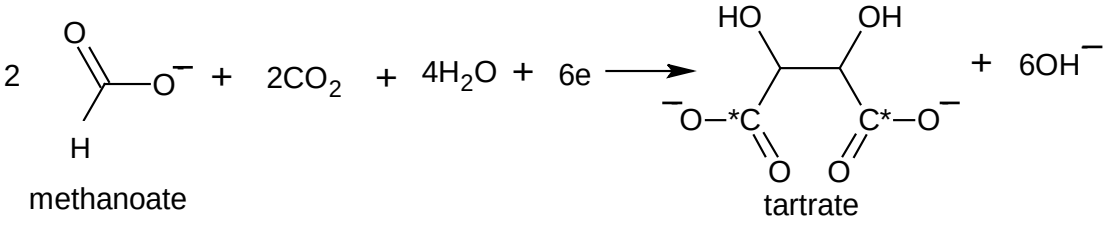
1 Electrons will flow from **Y** to **X** through the meter.

2 The voltmeter reading will increase when aqueous KCN is added to beaker **R**.

3 The voltmeter reading will decrease when water is added to beaker **Q**.

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

The methanoate anion and carbon dioxide can be simultaneously reduced to the tartrate anion in alkaline medium. The standard electrode potential of this half-cell is + 0.20 V.



methanoate tartrate

Which of the following statements are true?

1 The oxidation states of carbon are +4 and +2 in carbon dioxide and methanoate respectively.

2 Tartrate can be oxidised to methanoate and carbon dioxide using aqueous iodine.

3 When $^{14}CO_2$ is used in place of CO_2, the asterisked carbon atoms (C*) in the tartrate will be replaced with ^{14}C.

38 Deuterium, D, is an isotope of hydrogen.

Which mixtures, on heating, produce an alkaline gas containing deuterium?

1 $CH_3CH_2CONHCH_3$ and NaOD in D_2O

2 $(ND_2H_2)_2SO_4$ and NaOD in D_2O

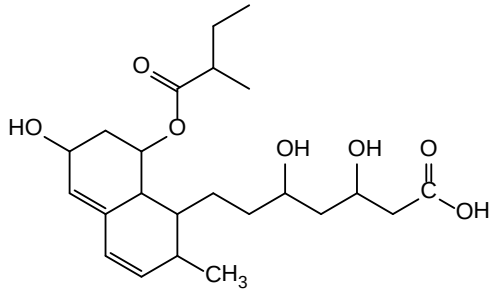
3 $C_6H_5CH_2CN$ and DC*l* in D_2O

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 *Pravastatin* is a drug used to lower cholesterol in the blood.



1 It reacts with liquid bromine in tetrachloromethane to form a compound with 12 chiral centres.

2 It reacts with acidified potassium manganate(VII) under reflux to form one organic product.

3 It reacts with 3 moles of hydrogen gas in the presence of nickel catalyst and heat.

40 Which of the following groups of compounds show an increasing rate of hydrolysis?

1 CH_3CH_2Cl, CH_3CH_2Br, CH_3CH_2I

2 CH_3COONa, C_6H_5ONa, CH_3CH_2ONa

3 CH_3CONH_2, CH_3COOCH_3, CH_3COCl

– End of Paper–