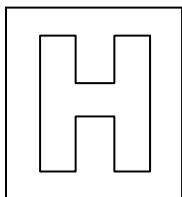


Candidate Name: _____

Class Adm No 784

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2013 Preliminary Examination II

Pre-university 3

H2 CHEMISTRY

9647/01

Paper 1 Multiple Choice

Tuesday, 24 Sep 2013

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.

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 **forty** 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.

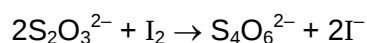
Section A

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

- 1 Which mass of gas would occupy a volume of 3 dm³ at room temperature and pressure?

- | | |
|-----------------------------------|-------------------------------------|
| A 3.2 g O ₂ gas | C 8.0 g SO ₂ gas |
| B 5.6 g N ₂ gas | D 11.0 g CO ₂ gas |

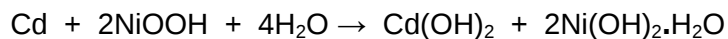
- 2 When an excess of KI solution was added to 10.0 cm³ of a 0.200 mol dm⁻³ solution of JO₄³⁻, the iodine liberated was titrated against a standard solution of 0.100 mol dm⁻³ of sodium thiosulfate, Na₂S₂O₃, using starch as the indicator.



If the volume of sodium thiosulfate required to discharge the blue–black colouration is 40.00 cm³, what is the final oxidation state of **J**?

- | | |
|-------------|-------------|
| A +1 | C +3 |
| B +2 | D +4 |

- 3 The nickel–cadmium rechargeable battery is based on the following overall reaction:



What is the oxidation number of nickel at the start and at the end of the reaction?

- | | Beginning | End |
|----------|------------------|------------|
| A | +2 | +2 |
| B | +2 | +3 |
| C | +3 | +2 |
| D | +3 | +4 |

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

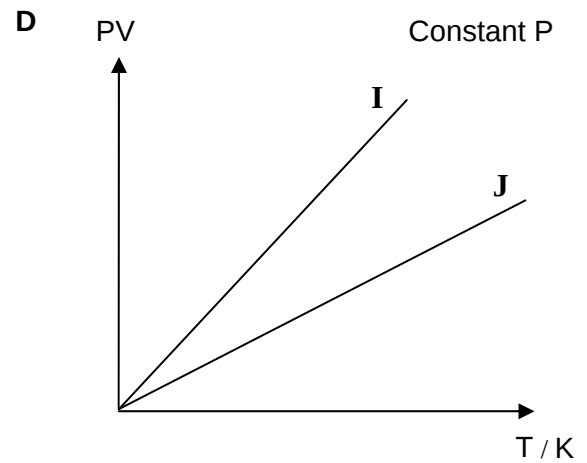
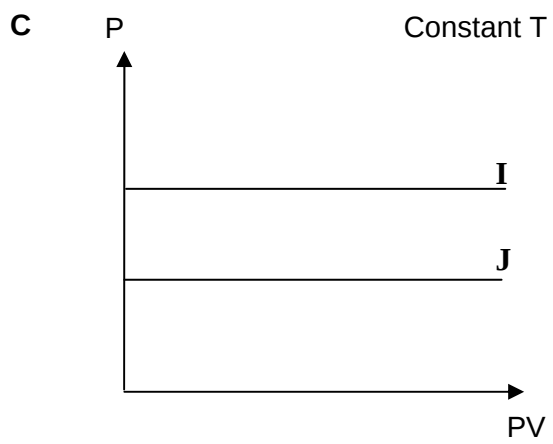
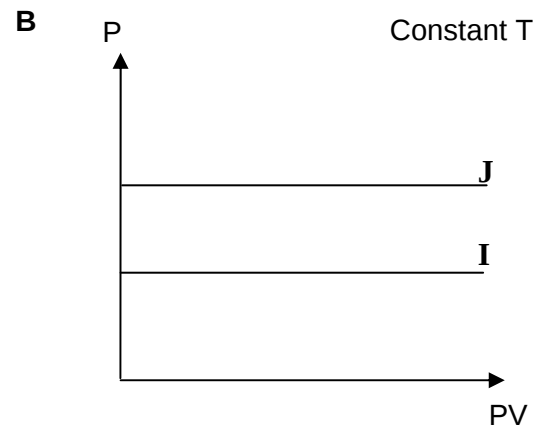
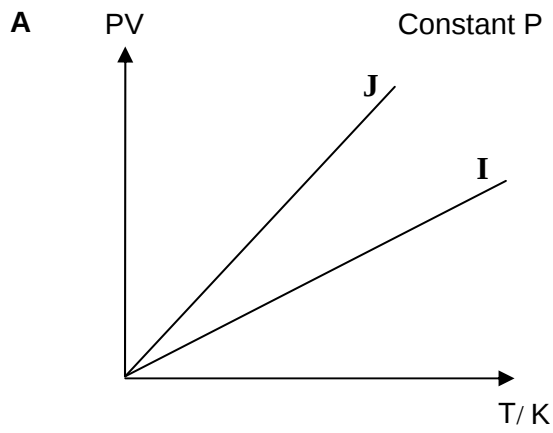
What could be the proton number of an element that has three unpaired electrons in each of its atoms?

- | | | | |
|----------|----|----------|----|
| A | 5 | C | 15 |
| B | 13 | D | 21 |

- 5 C_2H_4 and C_2H_2 are unsaturated hydrocarbons. Which of the following statements is correct regarding these two molecules?

- A** Both C_2H_4 and C_2H_2 have the same shape.
- B** C_2H_4 has more σ bonds but fewer π bonds than C_2H_2 .
- C** The carbons in C_2H_4 and C_2H_2 are sp and sp^2 hybridised respectively.
- D** The carbon–carbon–hydrogen bond angle is larger in C_2H_4 than in C_2H_2 .

- 6 Which graph correctly describes the behaviour of fixed masses of the ideal gases **I** and **J**, where **I** has a higher M_r than **J**?



- 7 Consider the equilibrium $3\text{J}_2(\text{g}) + 2\text{KJ}(\text{g}) \rightleftharpoons 2\text{KJ}_4(\text{g})$.
When 4 mol of KJ_4 was put into a 2 dm^3 container and heated, the equilibrium mixture contained 0.8 mol of KJ .

What is the numerical value of the equilibrium constant, K_c ?

- A 74.1
B 9.23
C 1.16
D 0.108
- 8 Graphite and diamond are two allotropes of carbon. Although graphite is thermodynamically more stable than diamond at 25°C and 1 atm, a piece of diamond will not transform into graphite, even over a period of one million years.

Which of the following correctly explains this observation?

- A ΔG for the reaction *diamond* $\longrightarrow$ *graphite* is greater than zero.
B ΔH for the reaction *diamond* $\longrightarrow$ *graphite* is greater than zero.
C The reverse reaction *graphite* $\longrightarrow$ *diamond* proceeds quickly.
D The reaction *diamond* $\longrightarrow$ *graphite* has a large activation energy.
- 9 Which combination of substances, when dissolved in 10 dm^3 of water, would give a buffer solution?
- A 1 mol HCl and 1 mol of CH_3COOH
B 1 mol CH_3COOH and 1 mol of CH_3COONa
C 1 mol HCl and 1 mol of CH_3COONa
D 1 mol of CH_3COOH and 1 mol of NaCl

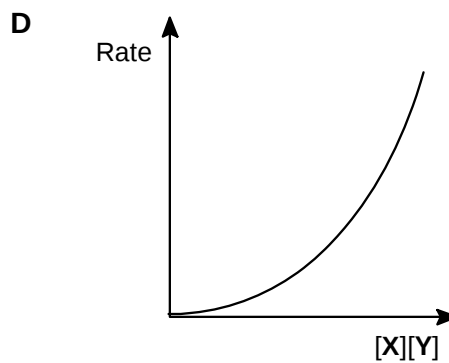
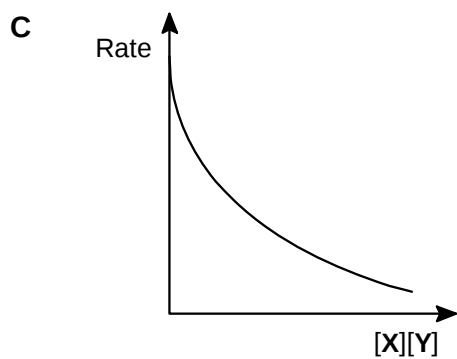
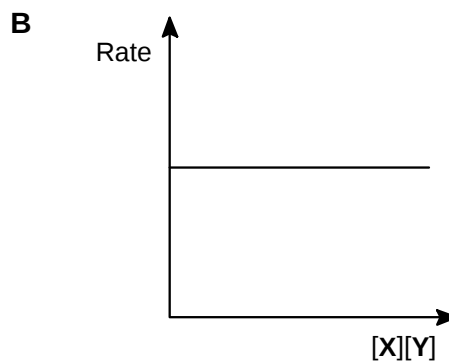
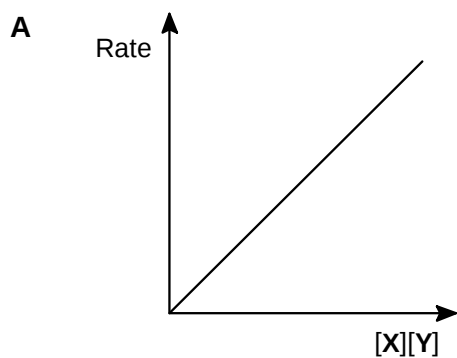
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- 10 The reaction between **X** and **Y** is an overall second–order reaction.

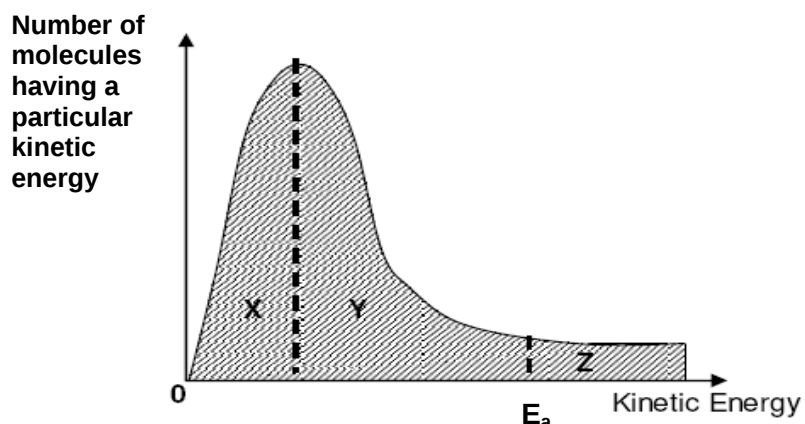


$$\text{where Rate} = k[\text{X}][\text{Y}]$$

The rate of this reaction is plotted against the product $[\text{X}][\text{Y}]$ of the concentrations of **X** and **Y**. Which graph would be obtained?



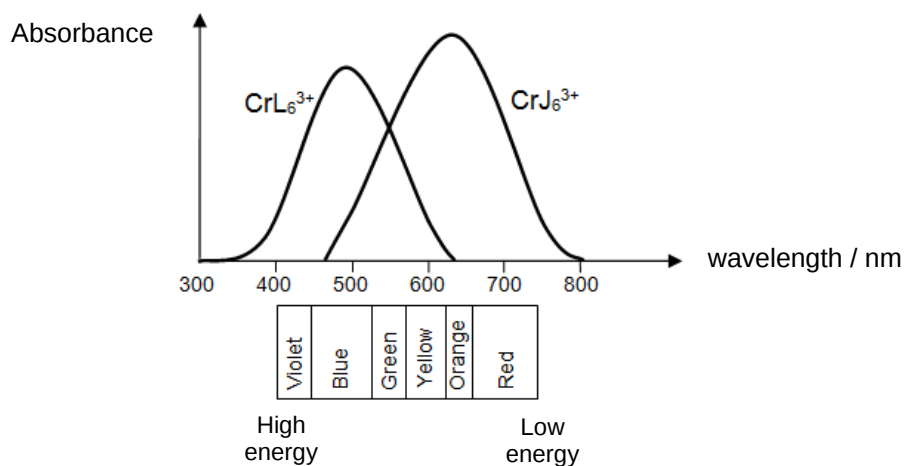
- 11** The Boltzmann distribution shows the number of molecules having a particular kinetic energy at constant temperature.



If the temperature is decreased by 20 °C, what happens to the size of the areas labelled X, Y and Z?

- | | X | Y | Z |
|----------|----------|----------|----------|
| A | Increase | Decrease | Increase |
| B | Increase | Decrease | Decrease |
| C | Decrease | Increase | Increase |
| D | Decrease | Increase | Decrease |
- 12** The reactivity of the Group II metals with oxygen increases down the group. Which statement best explains this trend?
- A** Electronegativity of the elements decreases down the group.
 - B** Ionic radii of the metal cations increase down the group.
 - C** Lattice energy of the metal oxides decreases down the group.
 - D** Reducing power of the elements increases down the group.

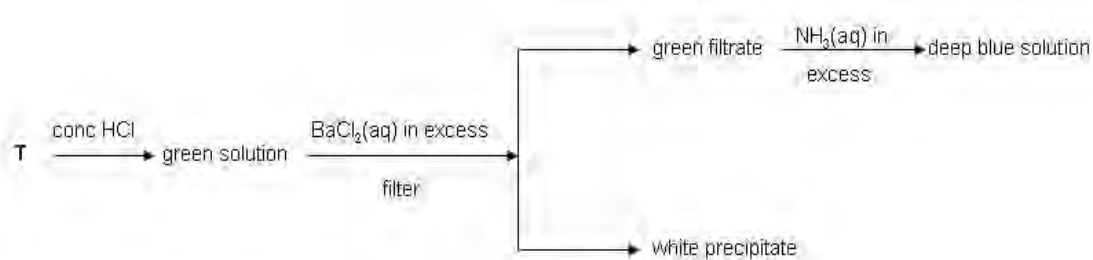
- 13 The diagram below shows the visible spectra of two chromium (III) complexes, CrL_6^{3+} and CrJ_6^{3+} . The various colours corresponding to the approximate wavelengths in the visible light region are shown below the axis.



What is the colour of each complex and which ligand causes a larger d-orbital splitting?

	<i>colour of CrL_6^{3+}</i>	<i>colour of CrJ_6^{3+}</i>	<i>ligand which causes a larger d-orbital splitting</i>
A	blue	yellow orange	L
B	blue	yellow orange	J
C	red	violet	L
D	red	violet	J

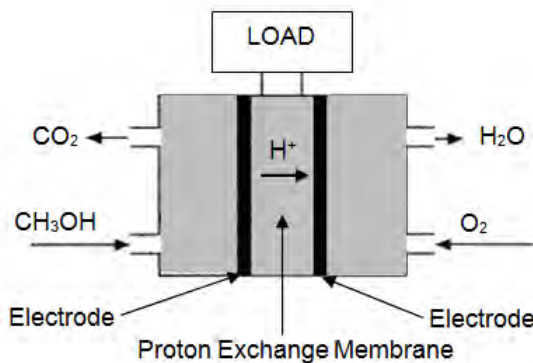
- 14 Below is a scheme of reaction for a salt **T**.



What is **T**?

- A chromium(III) chloride
- B chromium(III) sulfate
- C copper(II) chloride
- D copper(II) sulfate

- 15 Direct-methanol fuel cells make use of methanol as the fuel to generate energy. They are limited in the power they can produce, but can still store high energy content in a small space. The electrolyte in this fuel cell is a dilute aqueous acid.



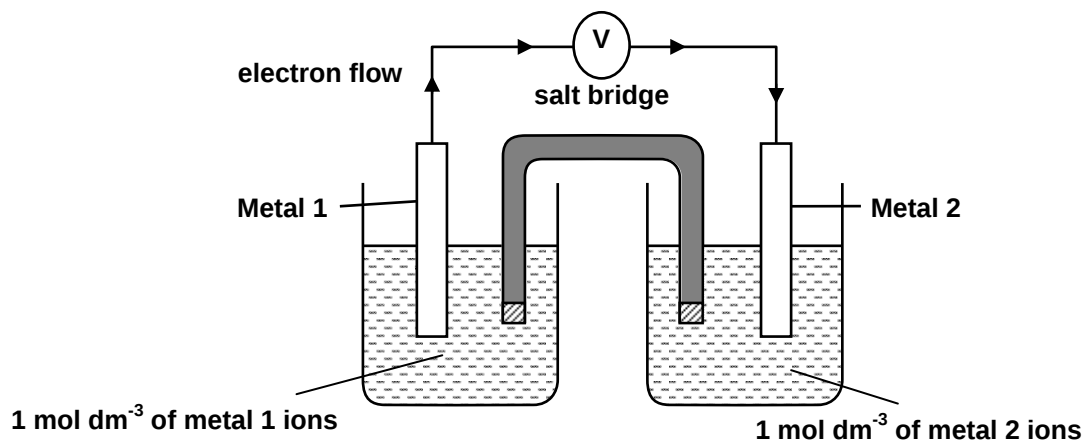
Which of the following statements is **incorrect**?

- A Methanol is oxidized in this reaction.
- B The proton exchange membrane functions as a salt bridge.
- C The pH at the anode increases temporarily as energy is generated.
- D Electrons flow from the methanol/carbon dioxide half-cell to that of the oxygen/ water half-cell.

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

The half-cells for four metals: Mg, X, Y and Z were in turn connected in pairs and the potential difference was recorded.

Temperature = 25°C



The results obtained are as shown in the table below.

Positive electrode	Negative electrode	e.m.f /V
X	Mg	+2.10
Y	Mg	+2.72
Mg	Z	+0.33

Rank the four metals in the order of decreasing reducing power.

- A Y > X > Mg > Z
- B X > Y > Mg > Z
- C Z > Mg > X > Y
- D Z > Mg > Y > X

17 How many isomers (structural and stereoisomers) are there in C₄H₉Br?

- | | |
|-----|-----|
| A 2 | C 4 |
| B 3 | D 5 |

18 Which of the following represents the correct structural formula of the organic product of reaction between $\text{CH}_3\text{CH}(\text{OH})\text{CH}_3$ and $\text{C}_2\text{H}_5\text{CO}_2\text{H}$?

- | | |
|---|---|
| A $\text{C}_2\text{H}_5\text{CO}_2\text{CH}_2\text{CH}_2\text{CH}_3$ | C $(\text{CH}_3)_2\text{CHCO}_2\text{C}_2\text{H}_5$ |
| B $\text{C}_2\text{H}_5\text{CO}_2\text{CH}(\text{CH}_3)_2$ | D $\text{C}_2\text{H}_5\text{OCOCH}_2\text{CH}_2\text{CH}_3$ |

19 Ethanoyl chloride is mixed with phenylamine. When the reaction is complete, the mixture is poured into cold water and a white substance is precipitated. Which of the following is most likely to be the precipitate?

- | | |
|---|--|
| A $\text{C}_6\text{H}_5\text{NH}_3^+\text{Cl}^-$ | C $\text{C}_6\text{H}_5\text{NHCOCH}_3$ |
| B $\text{C}_6\text{H}_5\text{CONHCH}_3$ | D $\text{C}_6\text{H}_5\text{COOCH}_2\text{NH}_2$ |

20 A substance, **H**, has the following properties:

- It reacts with aqueous sodium hydroxide to form an ionic compound.
- It reacts with phosphorus pentachloride giving off HCl fumes.
- It reacts with hydrogen in the presence of nickel catalyst.
- It reacts with ethanol.

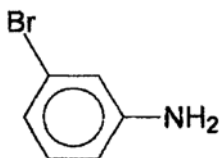
Which of the following is **H**?

- | | |
|--|---|
| A $\text{CH}_2=\text{CHCO}_2\text{H}$ | C CH_3CHO |
| B $\text{C}_6\text{H}_5\text{OH}$ | D $\text{CH}_2=\text{CHCH}_2\text{OH}$ |

21 Which one of the following reactions is **incorrect**?

- A** $2\text{CH}_3\text{CH}_2\text{CO}_2\text{H} + \text{CaO} \rightarrow \text{Ca}(\text{CH}_3\text{CH}_2\text{CO}_2)_2 + \text{H}_2\text{O}$
- B** $\text{CH}_3\text{COCO}_2\text{H} + 4[\text{H}] \rightarrow \text{CH}_3\text{COCH}_2\text{OH} + \text{H}_2\text{O}$
- C** $\text{CH}_3\text{COCH}_3 + \text{HCN} \rightarrow \text{CH}_3\text{C}(\text{OH})(\text{CN})\text{CH}_3$
- D** $\text{C}_6\text{H}_5\text{CO}_2\text{C}_6\text{H}_5 \xrightarrow[\text{heat}]{\text{NaOH(aq)}} \text{C}_6\text{H}_5\text{CO}_2^-\text{Na}^+ + \text{C}_6\text{H}_5\text{O}^-\text{Na}^+$

- 22 Which one of the following methods would you choose for the synthesis of the compound shown below starting from benzene?



- | | Step 1 | Step 2 | Step 3 |
|---|-------------|-------------|-------------|
| A | Nitration | Reduction | Bromination |
| B | Bromination | Reduction | Nitration |
| C | Bromination | Nitration | Reduction |
| D | Nitration | Bromination | Reduction |
- 23 In which of the following sequences does the value of pK_a decrease continuously?
- A $CH_3CO_2H > CCl_3CO_2H > C_2H_5OH > C_6H_5OH$
- B $CCl_3CO_2H > CH_3CO_2H > C_6H_5OH > C_2H_5OH$
- C $C_2H_5OH > C_6H_5OH > CH_3CO_2H > CCl_3CO_2H$
- D $C_6H_5OH > C_2H_5OH > CH_3CO_2H > CCl_3CO_2H$
- 24 In the hydrogenation of $CH_2=CHCH_2CN$ using platinum as a catalyst, the volume of hydrogen (measured at s.t.p.) that reacts with 1 mol of the compound could be:

- | | | | |
|---|---------------------|---|---------------------|
| A | 22.4 dm^3 | C | 44.8 dm^3 |
| B | 24.0 dm^3 | D | 67.2 dm^3 |

- 25 The base strengths of ammonia and ethylamine are different because of the electron-releasing properties of the ethyl group. Which one of the following pairs correctly shows the effect of the ethyl group?

	<i>effect on strength of $C_2H_5NH_2$ relative to NH_3 as a base</i>	<i>effect on strength of $C_2H_5NH_3^+$ relative to NH_4^+ as an acid</i>
A	increase	increase
B	increase	decrease
C	decrease	decrease
D	decrease	increase

- 26 **X**, **Y** and **Z** are three organic compounds. **X** gives a yellow precipitate with alkaline iodine. It undergoes oxidation with acidified potassium manganate(VII) to give **Y** and **Z**. **Y** gives a yellow precipitate with 2,4-dinitrophenylhydrazine but gives negative results with Tollen's reagent. **Z** reacts with sodium carbonate to give strong effervescence of carbon dioxide.

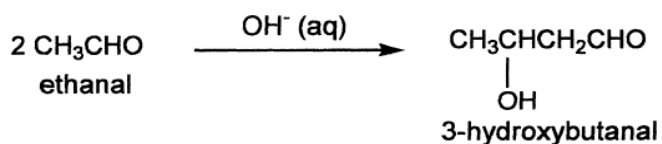
Which one of the following organic compounds could be **X**, **Y** and **Z**?

	X	Y	Z
A	$CH_3CH(OH)CH=CHCH_3$	CH_3COCHO	CH_3CO_2H
B	$CH_3CH(OH)C(CH_3)=CHCH_3$	CH_3CH_2COCHO	CH_3CO_2H
C	$CH_3CH(OH)C(CH_3)=CHCH_3$	$CH_3COCOCH_3$	CH_3CO_2H
D	$CH_3COC(CH_3)=C(CH_3)_2$	$CH_3COCOCH_3$	CH_3COCH_3

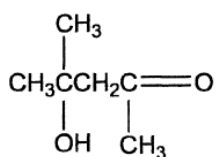
- 27 A certain organic compound reacts vigorously with water to give an acidic solution which instantly yields a precipitate of silver bromide when treated with aqueous silver nitrate. The compound could be:

A	$BrCH_2CH_2CO_2H$	C	$CH_3CH(OH)CH_2Br$
B	CH_3CH_2COBr	D	$C_6H_4Br(COOH)$

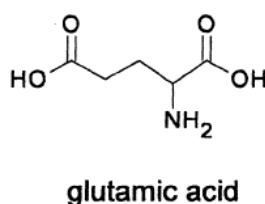
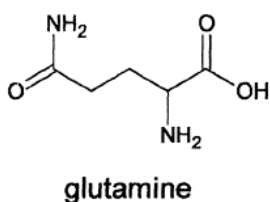
- 28** In the presence of a dilute alkali, some aldehydes and ketones undergo the "aldo reaction" where they dimerise to form a hydroxycarbonyl compound (an aldol). For example, ethanal dimerises in this way to form 3-hydroxybutanal.



Which of the following carbonyl compounds will undergo the aldol reaction to produce the aldol shown below?



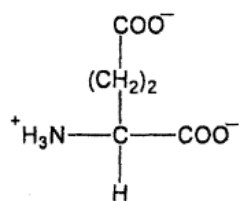
- A** CH_3COCH_3
B $(\text{CH}_3)_2\text{CHCHO}$
C $\text{CH}_3\text{CH}_2\text{CHO}$
D $\text{CH}_3\text{CH}_2\text{COCH}_3$
- 29** The amino acids glutamine and glutamic acid can react with each other to form amide linkages.



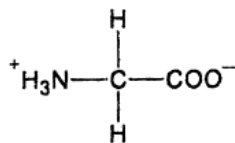
What is the maximum number of different compounds, each containing one amide linkage that can be formed from one molecule of glutamine and one molecule of glutamic acid?

- A** 2
B 3
C 4
D 5

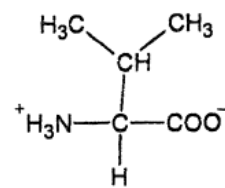
- 30 The following three amino acids exist as the following structures at neutral pH.



**glutamic acid
(Glu)**

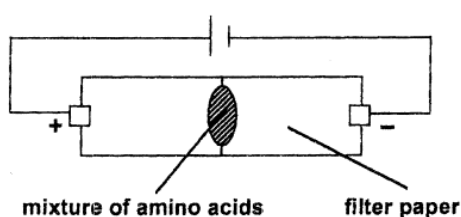


**glycine
(Gly)**

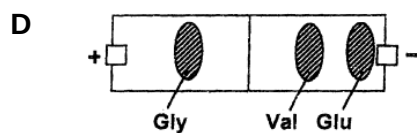
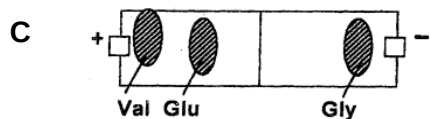
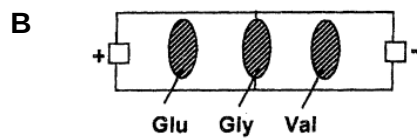
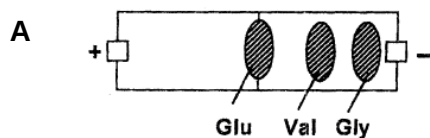


**valine
(Val)**

A mixture containing the three amino acids was placed in a solution of pH 3 and subjected to electrophoresis as follows.



Which one of the following filter papers shows a possible result of the separation of the amino acid mixture at pH 3?



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

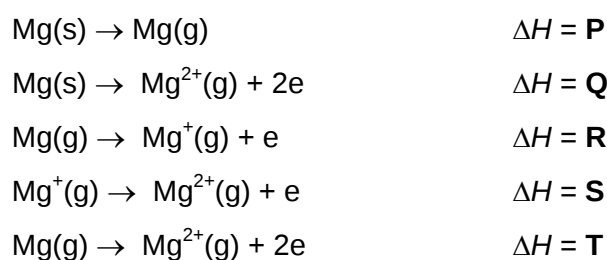
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

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

- 31** Which of the following particles would, on losing an electron, have a half-filled set of p orbitals?

- 1** N^-
- 2** C^-
- 3** O^+

- 32** Consider the following enthalpy changes in kJ mol^{-1} :



Which of the following statement(s) is/are **incorrect**?

- 1** **R** is equal to the first ionisation energy of Mg.
- 2** $(\text{Q} - \text{S} - \text{R})$ is greater than **P**.
- 3** **T** is **not** equal to the sum of **R** and **S**.

33 Which of the following reaction(s) is/are the sign of ΔS **incorrect**?

- | | | |
|----------|--|------------------------------|
| 1 | $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ | $\Delta S = \text{positive}$ |
| 2 | $HCl(aq) + NaHCO_3(aq) \rightarrow NaCl(aq) + CO_2(g) + H_2O(l)$ | $\Delta S = \text{positive}$ |
| 3 | $H_2O(l) \rightarrow H_2O(s)$ | $\Delta S = \text{negative}$ |

34 Tropaeolin indicator has a pH range of 7.6 to 9.0. Its colour is yellow at $pH < 7.6$ and rose-red at $pH > 9.0$. Which of the following statement(s) about Tropaeolin indicator is/are correct?

- 1** The indicator is yellow when 50 cm^3 of 0.20 mol dm^{-3} of aqueous NH_3 is mixed with 50 cm^3 of 0.85 mol dm^{-3} aqueous NH_4Cl (pK_a of NH_4^+ is 9.25).
- 2** It is suitable for titration of ethanoic acid against sodium hydroxide.
- 3** The indicator is rose-red in a solution of 0.01 mol dm^{-3} of methylamine.
($K_b = 4.37 \times 10^{-4} \text{ mol dm}^{-3}$)

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

X, **Y** and **Z** are Period 4 elements but are not necessarily arranged in order of increasing atomic number. Some of their properties are tabulated below.

Element	Density / g cm^{-3}	Melting point / $^{\circ}\text{C}$	Ion in which the element exists in its highest oxidation state	Formula and colour of a chloride formed by the element
X	—	−7	XO_4^-	XCl (red)
Y	1.5	850	$[Y(\text{edta})]^{2-}$	YCl_2 (white)
Z	7.2	1890	ZO_4^{2-}	ZCl_3 (purple)

Which of the following statement(s) is/are correct?

- 1** **X** has a smaller atomic radius than **Y**.
- 2** **Y** is not a transition element.
- 3** **Z** has six unpaired electrons in its ground state electronic configuration.

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

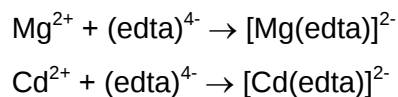
The number of moles of chlorine that react with 1 mole of **A** is twice the number of moles of chlorine that react with 1 mole of **B**. Which of the following pair(s) could be **A** and **B** respectively?

	A	B
1	Si(s)	Mg(s)
2	cold Na(OH)(aq)	hot NaOH(aq)
3	FeBr ₂ (aq)	KI(aq)

- 37 Which of the following properties will give a decreasing trend down Group VII?

- 1 Thermal stability of hydrogen halides
- 2 Reducing power of halides
- 3 Boiling point of halogens

- 38 A solution of edta and two divalent aqueous metal ions react as shown below:



where $(\text{edta})^{4-}$ is: $(\text{CH}_2\text{CO}_2^-)_2\text{NCH}_2\text{CH}_2\text{N}(\text{CH}_2\text{CO}_2^-)_2$

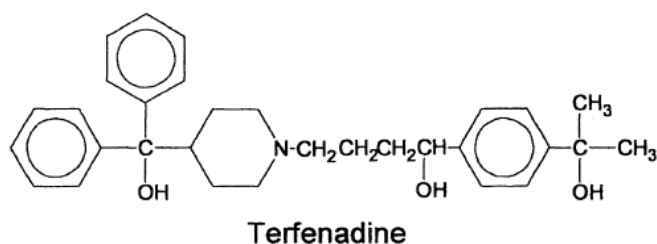
Which of the following statement(s) is/are true?

- 1 Both are ligand exchange reactions.
- 2 Both $[\text{Mg}(\text{edta})]^{2-}$ and $[\text{Cd}(\text{edta})]^{2-}$ are octahedral complexes.
- 3 The product formed from each reaction is coloured.

39 Which of the following are propagation steps in the reaction between methane and chlorine under UV light?

- 1** $\bullet\text{CH}_3 + \text{Cl}_2 \rightarrow \text{CH}_3\text{Cl} + \text{Cl}\bullet$
- 2** $\text{CH}_2\text{Cl}_2 + \text{Cl}\bullet \rightarrow \bullet\text{CHCl}_2 + \text{HCl}$
- 3** $\text{CH}_4 + \text{Cl}\bullet \rightarrow \text{CH}_3\text{Cl} + \text{H}\bullet$

40 Terfenadine alleviates seasickness and asthma in the same way as the older drugs, but it does not cause drowsiness as a side effect.



What deduction(s) about Terfenadine can be made from this structure?

- 1** One mole of Terfenadine will give out one mole of hydrogen on reaction with two moles of sodium.
- 2** It can be oxidized to form a product which does not react with hot Tollen's reagent.
- 3** It decolorises $\text{KMnO}_4(\text{aq})$ under acidic conditions.

END OF PAPER

[Turn over