

RAFFLES JUNIOR COLLEGE
PRELIMINARY EXAMINATION 2008

HIGHER 2



CHEMISTRY

9746/01

Paper 1 Multiple Choice

19 September 2008

1 hour

Additional Materials: Multiple Choice answer sheet
Data Booklet

READ THESE INSTRUCTIONS FIRST

DO NOT open this question booklet until you are told to do so.

Write in soft pencil.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Write your name, Candidate Number on the Answer Sheet in the spaces provided.

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 to be correct and record your choice with a **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 An element **Z** has a second ionisation energy higher than that of the element preceding it and the element after it in the Periodic Table.

What is the atomic number of **Z**?

- A** 10 **B** 13 **C** 14 **D** 15

- 2 The use of the **Data Booklet** is relevant to this question.

The pH of pure water is 7.0 at 298 K. Which of the following quantities is equal to the number of ions in 1 dm³ of pure water at 298 K?

- A** The number of atoms in 4.48×10^{-6} dm³ of Cl₂ at s.t.p.
B The number of neutrons in 8.0×10^{-7} g of deuterium gas, D₂ (D = ²H).
C The number of molecules in 1.44×10^{-4} g of Buckminsterfullerene, C₆₀.
D The number of anions in 1.0×10^{-14} dm³ of 1.0 mol dm⁻³ K₃[Fe(CN)₆](aq).

- 3 Self-igniting flares contain Mg₃P₂. With water this produces diphosphane, P₂H₄, which is spontaneously flammable in air.

Which equation that includes the formation of diphosphane is balanced?

- A** $\text{Mg}_3\text{P}_2 + 6\text{H}_2\text{O} \longrightarrow 3\text{Mg}(\text{OH})_2 + \text{P}_2\text{H}_4$
B $\text{Mg}_3\text{P}_2 + 6\text{H}_2\text{O} \longrightarrow 3\text{Mg}(\text{OH})_2 + \text{P}_2\text{H}_4 + \text{H}_2$
C $2\text{Mg}_3\text{P}_2 + 12\text{H}_2\text{O} \longrightarrow 6\text{Mg}(\text{OH})_2 + \text{P}_2\text{H}_4 + 2\text{PH}_3$
D $2\text{Mg}_3\text{P}_2 + 12\text{H}_2\text{O} \longrightarrow 6\text{Mg}(\text{OH})_2 + 3\text{P}_2\text{H}_4$

- 4 Which of the following statements is correct?

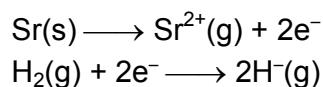
- A** XeF₄ and H₂C=C=CH₂ are planar molecules.
B BCl₃ and BrCl₃ have the same molecular shape.
C Benzene and cyclohexene are non-polar liquids.
D LiAlH₄ and NaBF₄ contain dative covalent bonds.

- 5 Which of the following changes will have the greatest effect on the density of a fixed mass of an ideal gas?

	Pressure	Temperature / K
--	----------	-----------------

- | | | |
|----------|---------|----------|
| A | doubles | halves |
| B | doubles | doubles |
| C | halves | halves |
| D | halves | constant |

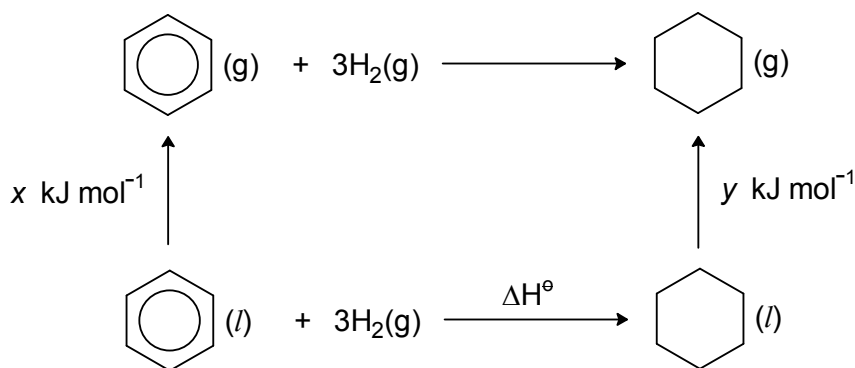
- 6 Strontium hydride is an ionic compound. The standard enthalpy changes for the following two reactions related to its constituent elements and ions are known.



What additional data is needed to determine the lattice energy of strontium hydride?

- A The first ionisation energy of hydrogen.
B The standard enthalpy change of atomisation of hydrogen.
C The standard enthalpy change of atomisation of strontium.
D The standard enthalpy change of formation of strontium hydride.
- 7 The use of the **Data Booklet** is relevant to this question.

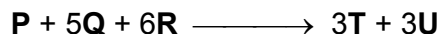
Consider the energy cycle given below.



What is the standard enthalpy change of hydrogenation of benzene, ΔH° , in kJ mol^{-1} ?

- A $x - y - 132$
B $x - y - 372$
C $y - x - 132$
D $y - x - 372$
- 8 An increase in temperature increases the rate of a chemical reaction. For a given temperature rise, the rate will be most affected if the reaction
- A is exothermic.
B is endothermic.
C has a low activation energy.
D has a high activation energy.

- 9 **P**, **Q** and **R** react in aqueous solution according to the following equation:

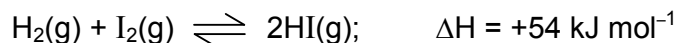


The kinetics of the above reaction was studied by the method of initial rates and the experimental results obtained are shown in the table below.

Experiment	Volume of 1.0 mol dm ⁻³ P /cm ³	Volume of 1.0 mol dm ⁻³ Q /cm ³	Volume of 1.0 mol dm ⁻³ R /cm ³	Volume of water /cm ³	Total volume of solution /cm ³	Relative initial rate of formation of T
(1)	10	50	60	80	200	1
(2)	10	25	120	45	200	2
(3)	5	25	60	10	100	4
(4)	10	25	60	5	100	8

What is the rate equation for the reaction?

- A** Rate = $k [\text{P}][\text{Q}]$
B Rate = $k [\text{P}][\text{Q}][\text{R}]$
C Rate = $k [\text{P}][\text{Q}]^2[\text{R}]$
D Rate = $k [\text{P}][\text{Q}][\text{R}]^2$
- 10 Two experiments were performed involving the following equilibrium.



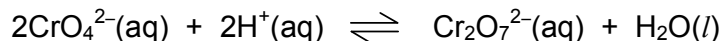
In experiment (1) carried out at temperature T_1 K, the equilibrium constant, $K_c = 64$.

In experiment (2) carried out at temperature T_2 K, 1.0 mol of H_2 and 1.0 mol of I_2 were initially added into a 1 dm³ flask. The flask was found to contain 1.2 mol of HI at equilibrium.

What is the relationship between T_1 and T_2 ?

- A** $T_1 > T_2$
B $T_1 = T_2$
C $T_1 < T_2$
D The relationship cannot be determined.

- 11 Which statement concerning the equilibrium reaction given below is correct?



- A A redox reaction is taking place.
 B The equilibrium constant, K_c , has no units.
 C A decrease in pH will result in an increase in the concentration of $\text{Cr}_2\text{O}_7^{2-}(\text{aq})$.
 D The addition of a catalyst will result in an increase in the concentration of $\text{Cr}_2\text{O}_7^{2-}(\text{aq})$.
- 12 Bromocresol green is an acid-base indicator with a pH range of 3.8 to 5.4. The acidic colour of the indicator is yellow and the alkaline colour is blue.

Two drops of the indicator are added to each of the four aqueous solutions listed below. Which solution has its colour **not** correctly stated?

Solution	Colour
A Saturated aqueous solution of $\text{Ca}(\text{OH})_2$.	blue
B Aqueous solution containing $1 \text{ mol dm}^{-3} \text{ CH}_3\text{COOH}(\text{aq})$ ($\text{p}K_a = 4.7$) and $1 \text{ mol dm}^{-3} \text{ CH}_3\text{COONa}(\text{aq})$.	green
C Dilute HCl of concentration $2.0 \times 10^{-5} \text{ mol dm}^{-3}$.	yellow
D Aqueous BaCl_2 of concentration $5.0 \times 10^{-3} \text{ mol dm}^{-3}$.	blue

- 13 Some standard reduction potentials are given in the table below.

Half-equation	$E^\ominus / \text{V}$
$2\text{H}_2\text{SO}_3 + 2\text{H}^+ + 4\text{e}^- \rightleftharpoons \text{S}_2\text{O}_3^{2-} + 3\text{H}_2\text{O}$	E_1
$[\text{SnCl}_6]^{2-} + 2\text{e}^- \rightleftharpoons \text{Sn}^{2+} + 6\text{Cl}^-$	E_2
$\frac{1}{2}\text{Hg}_2^{2+} + \text{e}^- \rightleftharpoons \text{Hg}(\text{l})$	E_3
$\text{Sb}_2\text{O}_5 + 6\text{H}^+ + 4\text{e}^- \rightleftharpoons 2[\text{Sb}(\text{OH})_2]^+ + \text{H}_2\text{O}$	E_4

A redox reaction occurs when Sb_2O_5 is mixed with $\text{S}_2\text{O}_3^{2-}$, but no reaction occurs when Sb_2O_5 is mixed with Hg . A solution of $[\text{SnCl}_6]^{2-}$ has no effect on $\text{S}_2\text{O}_3^{2-}$.

Which of the following gives the order of the standard reduction potentials from highest to lowest?

- A $E_2 > E_1 > E_4 > E_3$
 B $E_2 > E_4 > E_1 > E_3$
 C $E_3 > E_1 > E_4 > E_2$
 D $E_3 > E_4 > E_1 > E_2$

14 Elements **X**, **Y** and **Z** are in Period 3 of the Periodic Table.

X has the highest melting point among all the Period 3 elements.

The chloride of **Y** has the highest boiling point among all the Period 3 chlorides.

The oxide of **Z** has the highest melting point among all the Period 3 oxides.

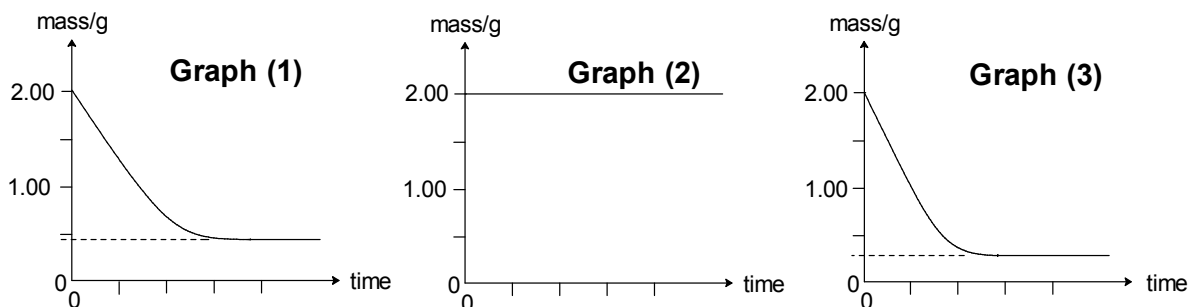
Which of the following statements is correct?

- A** The first ionisation energy increases in the following order: **Y** < **X** < **Z**.
- B** The electrical conductivity increases in the following order: **Z** < **Y** < **X**.
- C** The electronegativity increases in the following order: **X** < **Y** < **Z**.
- D** The atomic radius increases in the following order: **X** < **Z** < **Y**.

15 Magnesium iodates(V) undergoes thermal decomposition to yield products as shown by the equation below. The other Group II iodates(V) also undergo similar thermal decomposition.



The three graphs given below show the change in mass when 2.00 g each of three Group II iodates(V) were heated separately at a temperature $T^\circ\text{C}$.



Which three Group II iodates(V) give rise to these graphs?

	Graph (1)	Graph (2)	Graph (3)
A		$\text{Ca}(\text{IO}_3)_2$	$\text{Mg}(\text{IO}_3)_2$ $\text{Ba}(\text{IO}_3)_2$
B		$\text{Mg}(\text{IO}_3)_2$	$\text{Ba}(\text{IO}_3)_2$ $\text{Sr}(\text{IO}_3)_2$
C		$\text{Sr}(\text{IO}_3)_2$	$\text{Ba}(\text{IO}_3)_2$ $\text{Ca}(\text{IO}_3)_2$
D		$\text{Ca}(\text{IO}_3)_2$	$\text{Mg}(\text{IO}_3)_2$ $\text{Sr}(\text{IO}_3)_2$

- 16 Radium and astatine are radioactive elements. Radium is below barium while astatine is below iodine in the Periodic Table.

Which of the following would be a correct prediction for these elements and their compounds?

- A Radium will react more readily with oxygen than calcium.
- B Radium chloride will dissolve in water to yield an acidic solution.
- C Astatine will react with aqueous iron(II) ions to yield aqueous iron(III) ions.
- D Hydrogen astatide will be thermally more stable than hydrogen bromide.

- 17 X_2 , Y_2 and Z_2 are Cl_2 , Br_2 and I_2 but are not necessarily in the given order.

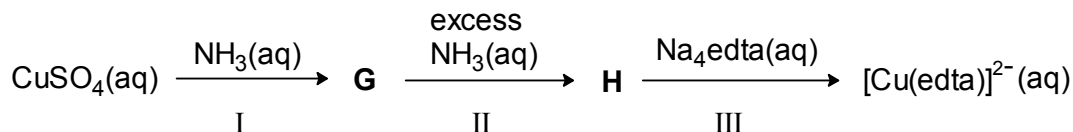
The table below shows the results of two experiments involving the addition of these halogens to separate aqueous solutions containing the halide ions followed by the addition of an organic solvent.

<i>Experiment</i>	<i>Reactants</i>	<i>Observation after addition of CCl_4 and the mixture shaken</i>
1	$X_2(aq) + Y^-(aq)$	violet organic layer
2	$Z_2(aq) + X^-(aq)$	violet organic layer
3	$X_2(aq) + Z^-(aq)$	Observation (3)
4	$Y_2(aq) + X^-(aq)$	Observation (4)

Which of the following statements is correct?

- A X^- is less reducing than Y^- .
- B Z_2 is a stronger oxidising agent than Y_2 .
- C Observation (3) is: violet organic layer.
- D Observation (4) is: reddish–brown organic layer.

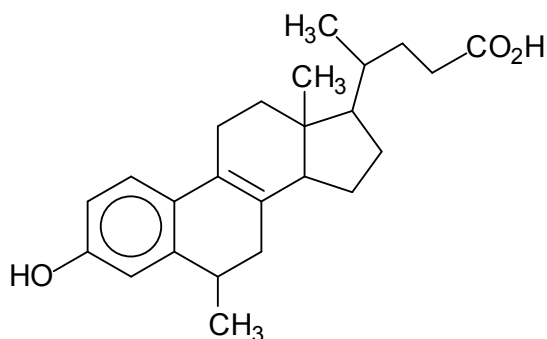
- 18 A reaction scheme starting from aqueous copper(II) sulphate solution is shown below. Both **G** and **H** are copper-containing species.



Which of the following statements is correct?

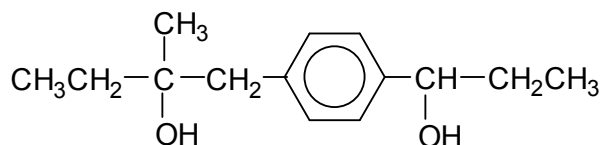
- A NH_3 is a ligand in reaction I.
- B Reaction II is a redox reaction.
- C **H** is a deep blue solution containing $[\text{Cu}(\text{NH}_3)_4(\text{H}_2\text{O})_2]\text{SO}_4$.
- D The entropy of the system decreases when reaction III occurs.

19 How many optical isomers does this organic molecule have?



- A** 8 **B** 16 **C** 32 **D** 64

20 The compound shown below is a derivative of ibuprofen which is used as a painkiller.



How many isomers (including stereoisomers) would be formed when this derivative of ibuprofen reacts with hot concentrated sulphuric acid?

- A** 4 **B** 6 **C** 8 **D** 10

21 In the hydrogenation of $\text{CH}_2=\text{CHCH}_2\text{CN}$ using platinum catalyst, the volume of hydrogen (measured at s.t.p.) that reacts with 1 mole of the compound could be

- A** 22.4 dm³
B 24.0 dm³
C 44.8 dm³
D 67.2 dm³

22 2-Methylpropanoic acid may be synthesised from 1-bromopropane through a series of reactions.

Which set of reagents, used in sequential order, would be the most suitable for this synthesis?

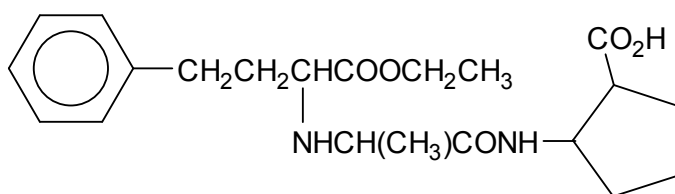
- A** aqueous KOH, acidified KMnO_4
B aqueous KOH, PCl_5 , ethanolic KCN, dilute H_2SO_4
C ethanolic KOH, HBr, ethanolic KCN, dilute H_2SO_4
D ethanolic KOH, HBr, HCN with NaOH catalyst, dilute HCl

- 23 The reduction of a nitrile **Q** produced a compound of the formula $\text{CH}_3\text{CH}_2\text{NH}_2$. The same nitrile **Q** was then hydrolysed in acidic medium.

What would be formed if the products from the two reactions are mixed together?

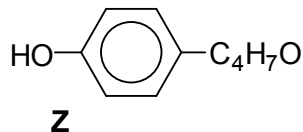
- A $\text{CH}_3\text{CONHCH}_2\text{CH}_3$
- B $\text{CH}_3\text{CH}_2\text{CONHCH}_2\text{CH}_3$
- C $(\text{CH}_3\text{CO}_2^-)(\text{CH}_3\text{CH}_2\text{NH}_3^+)$
- D $(\text{CH}_3\text{CH}_2\text{CO}_2^-)(\text{CH}_3\text{CH}_2\text{NH}_3^+)$

- 24 *Enalapril* is used to treat hypertension. Its structure is shown below.



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

- A *Enalapril* reacts with cold, aqueous HCl .
 - B One mole of *Enalapril* reacts with 2 moles of CH_3COCl .
 - C *Enalapril* decolourises acidified aqueous KMnO_4 when heated.
 - D One mole of *Enalapril* reacts with 3 moles of aqueous NaOH when heated.
- 25 The molecule **Z** below is the substance chiefly responsible for the smell of ripe raspberries.

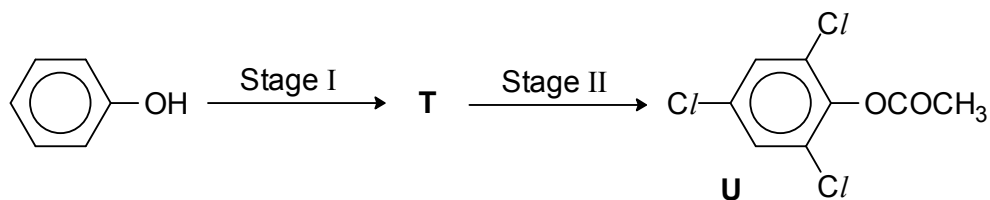


Z gives yellow precipitate with alkaline aqueous iodine, orange precipitate with 2,4-dinitrophenylhydrazine and contains a chiral carbon atom.

Which of the following could be the $-\text{C}_4\text{H}_7\text{O}$ group in **Z**?

- | | |
|--|--|
| <p>A $\text{CH}_2=\underset{ }{\text{C}}-\text{CH}(\text{OH})\text{CH}_3$</p> | <p>C $\text{O}=\underset{ }{\text{C}}-\text{CH}(\text{CH}_3)_2$</p> |
| <p>B $\text{CH}_3-\underset{ }{\text{CH}}-\text{COCH}_3$</p> | <p>D $(\text{CH}_3)_2\underset{ }{\text{C}}-\text{CHO}$</p> |

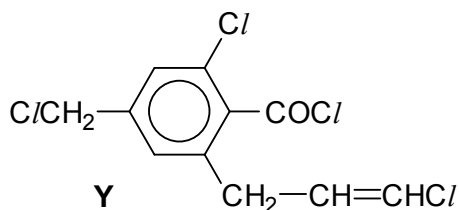
26 Phenol can be converted to a compound **U** as shown below.



Which of the following statements is correct with regards to the given reaction scheme?

- A** Stage I may involve the use of Cl_2 in CCl_4 .
- B** Stage I may involve the use of ethanoic acid and conc. H_2SO_4 as a catalyst.
- C** Stage II may involve the use of aqueous Cl_2 .
- D** Stage II may involve the use of ethanoyl chloride.

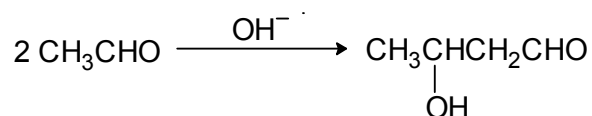
27 Consider the compound **Y**, which has the structural formula as shown.



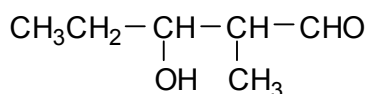
1 mole of compound **Y** is warmed with aqueous sodium hydroxide. The resulting solution is cooled and acidified with dilute nitric acid. How many moles of silver chloride will be precipitated out when excess aqueous silver nitrate is then added?

- A** 1 **B** 2 **C** 3 **D** 4

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

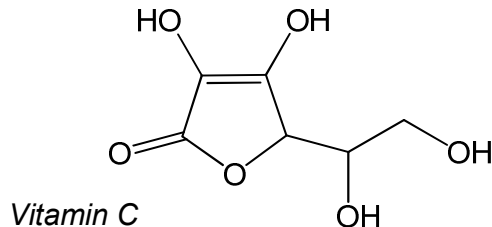


Which of the following carbonyl compounds will undergo the aldol reaction to produce the aldol shown below?



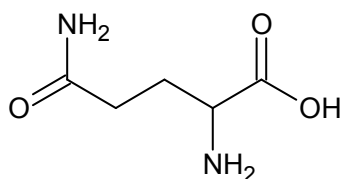
- | | |
|---|--|
| A $\text{CH}_3\text{CH}_2\text{CHO}$ | C CH_3COCH_3 |
| B $\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{CHO}$ | D $\text{CH}_3\text{CH}_2\text{COCH}_3$ |

- 29 *Vitamin C* is a water soluble compound that traps radicals formed in the aqueous environment of the cell and in blood plasma.

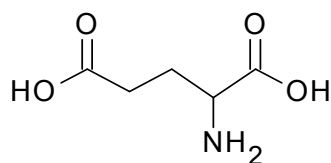


1 mole of *Vitamin C* reacts with

- A Na to produce 2 moles of H_2 .
 - B $\text{CH}_3\text{CH}_2\text{COCl}$ to produce 2 moles of HCl .
 - C Br_2 in CCl_4 to give a product with 3 chiral centres.
 - D H_2 in the presence of Pt to give a product with 2 chiral centres.
- 30 The amino acids glutamine and glutamic acid can react with each other to form amide linkages.



glutamine



glutamic acid

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

Section B

For each of the following questions, one or more of the three numbered statements 1 to 3 may be correct.

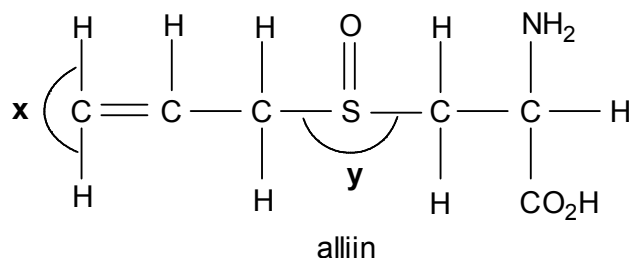
Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements that you consider to be correct).

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

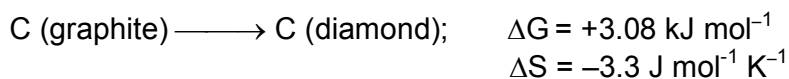
No other combination of statements is used as a correct response.

- 31 The characteristic smell of garlic is due to alliin. When garlic is cut an enzyme releases alliin because alliin has the right shape to fit the enzyme molecule.



Which of the following statements are **not** correct?

- 1 There are two sp^2 hybridised carbon atoms in a molecule of alliin.
 - 2 The molecule of alliin contains 18 sigma bonds and 3 pi bonds.
 - 3 The bond angle **x** is equal to the bond angle **y**.
- 32 The conversion of graphite into diamond is a non-spontaneous reaction at 298 K. The entropy change of this reaction is negative at 298 K.



With reference to the enthalpy change of the above reaction, ΔH , which of the following statements are correct?

- 1 The bond energy of the carbon-carbon bonds in graphite is greater than that in diamond.
- 2 The enthalpy change of atomisation of diamond is less endothermic than that of graphite.

- 3 The enthalpy change of combustion of diamond is more exothermic than that of graphite.

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

- 33 The use of the **Data Booklet** is relevant to this question.

Hydrangeas are flowering plants which commonly have pink flowers. They produce blue flowers only in soils which contain high concentrations of $\text{Mg}^{2+}(\text{aq})$. The pH of well limed soil is 9, whereas the pH of peat-based soil is 6.5. The numerical value of the solubility product, K_{sp} , of magnesium hydroxide is 1.8×10^{-12} .

Which of the following statements are correct?

- 1 The theoretical maximum value of $[\text{Mg}^{2+}(\text{aq})]$ in a well limed soil is $1.8 \times 10^{-2} \text{ mol dm}^{-3}$.
- 2 The theoretical maximum value of $[\text{Mg}^{2+}(\text{aq})]$ in a peat-based soil is higher than the $[\text{Mg}^{2+}(\text{aq})]$ in a saturated solution of magnesium hydroxide.
- 3 Peat-based soil is better than well limed soil for the cultivation of hydrangeas with pink flowers.

- 34 The use of the **Data Booklet** is relevant to this question.

The colours of various vanadium ions in aqueous solution are given in the table below.

Oxidation state	V	IV	III	II
Ion	VO_2^+	VO^{2+}	V^{3+}	V^{2+}
Colour	yellow	blue	green	violet

Which of the following reactions (if any) can produce a green solution?

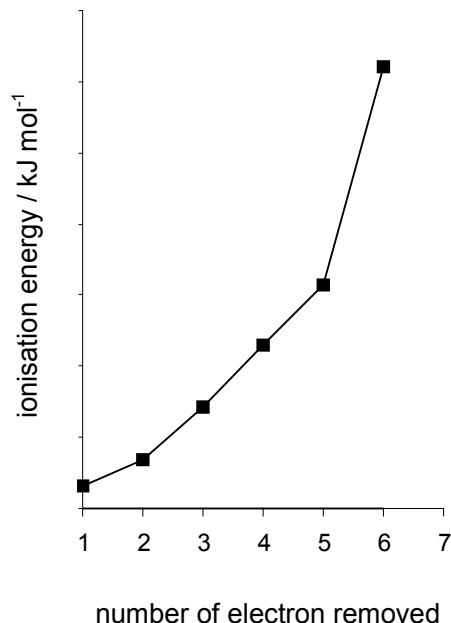
- 1 Adding excess Sn^{4+} ions to an acidified solution containing V^{2+} ions.
- 2 Bubbling excess SO_2 into an acidified solution of VO_2^+ ions.
- 3 Adding $\text{K}_2\text{S}_2\text{O}_8$ to an acidified solution containing VO_2^+ ions.

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

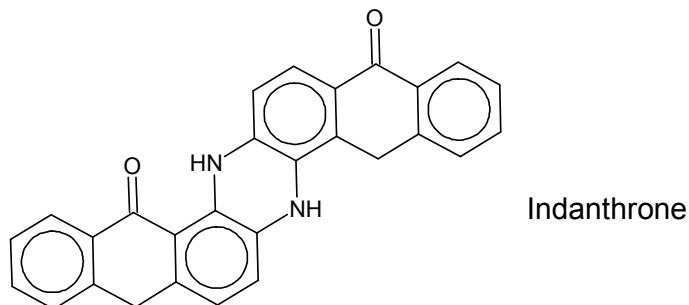
- 35 An element **X** in Period 4 is an electrical conductor at room temperature. The graph on the right shows the ionisation energies for the first six electrons in an atom of an element **X**.

Which of the following statements are correct?

- X** is a Group V element.
- X** can form coloured XC_3 and XC_5 .
- X^+ ion has four unpaired electrons.



- 36 Which of the following about methylbenzene and its derivatives are correct?
- There are four aromatic isomers of molecular formula $\text{C}_7\text{H}_7\text{Cl}$.
 - Methylbenzene reacts with warm acidified potassium dichromate(VI) solution.
 - Methylbenzene is a planar molecule.
- 37 Anthraquinoid dyes are of enormous technological importance, and much work has been done in devising syntheses of large ring systems embodying the quinone structure. The structure of Indanthrone, an anthraquinoid dye is given below:

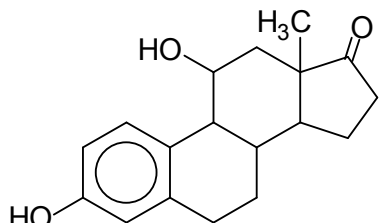


Which of the following statements is correct of Indanthrone?

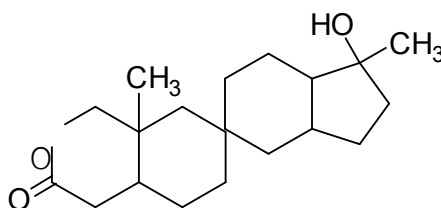
- It reacts with cold aqueous hydrochloric acid.
- It is able to form intramolecular hydrogen bonds.
- It gives a brick red precipitate when warmed with Fehling's solution.

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 The structures of compounds **C** and **D** are as shown below:



C

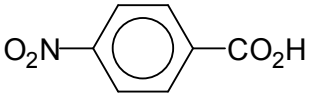


D

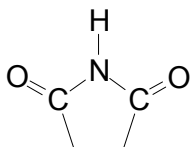
Which of the following reagents can be used to distinguish **C** and **D**?

- 1** 2,4-dinitrophenylhydrazine
- 2** neutral aqueous iron(III) chloride solution
- 3** hot acidified potassium manganate(VII) solution

39 In which of the following sequences does the value of pK_a decrease?

- 1** $\text{CH}_3\text{CH}_2\text{CF}_2\text{CO}_2\text{H} > \text{CH}_3\text{CHFCHFCO}_2\text{H} > \text{CH}_2\text{FCH}_2\text{CHFCO}_2\text{H}$
- 2**  $>$  $>$ 
- 3** $\text{C}_6\text{H}_5\text{OH} > \text{CH}_3\text{CO}_2\text{H} > \text{CCl}_3\text{CO}_2\text{H}$

40 Compound **X** has the structural formula as shown below:



Which of the following statements regarding **X** are correct?

- 1** **X** can react with boiling aqueous NaOH with the evolution of NH_3 .
- 2** **X** can react with LiAlH_4 in dry ether to give a cyclic secondary amine.
- 3** **X** can react with boiling dilute HCl to yield an amino acid.

----- End of Paper -----

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1	B	11	C	21	D	31	A
2	C	12	C	22	C	32	A
3	B	13	D	23	C	33	B
4	D	14	D	24	B	34	B
5	A	15	C	25	B	35	C
6	D	16	A	26	D	36	D
7	A	17	C	27	B	37	B
8	D	18	C	28	A	38	B
9	D	19	C	29	A	39	C
10	A	20	D	30	B	40	B