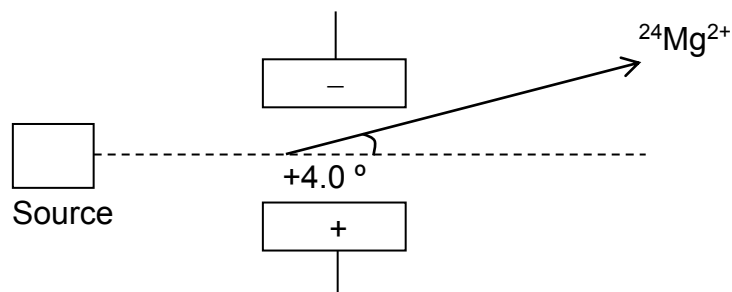


For each question there are four possible answers, **A**, **B**, **C**, and **D**. Choose the **one** you consider to be correct.

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

In an experiment, a sample containing 2 different species was vaporised, ionised and passed through an electric field. Analysis of the deflection occurring at the electric region revealed the following data for the sample. It was observed that a beam of $^{24}\text{Mg}^{2+}$ gives an angle of deflection of $+4.0^\circ$.



Which one of the following species will give the correct angle of deflection?

	isotope	no. of electrons	angle of deflection
A	^{16}O	6	-6.0°
B	^{23}Na	10	$+2.1^\circ$
C	^{28}Si	10	-6.9°
D	^{35}Cl	18	$+1.4^\circ$

- 2** Which one of the following corresponds to the electronic configuration of the 6 outermost electrons of a Group 6 element in its ground state?

- A** $3d^4 4s^2$
- B** $3d^5 4s^1$
- C** $4s^2 4p^4$
- D** $4p^6$

- 3** Which of the following have species arranged in increasing bond angle about the central atom?

- 1** ICl_4^- , IO_3^- , I_3^-
- 2** XeF_4 , XeO_3 , XeF_2
- 3** N_2O , NO_3^- , NO_2^+
- 4** SO_4^{2-} , SO_3^{2-} , SO_2

- A** **1** and **2** only
- B** **1**, **2** and **4** only
- C** **1**, **3** and **4** only
- D** **2** and **3** only

- 4 The molar mass of ethanoic acid is 120.0 g mol^{-1} when dissolved in trichloromethane but 60.0 g mol^{-1} when dissolved in water.

Which one of the following statements best explains the phenomenon?

- A Ethanoic acid is more soluble in trichloromethane than in water.
- B Ethanoic acid molecules form strong covalent bonds with trichloromethane molecules.
- C Ethanoic acid evaporates more readily in water.
- D Ethanoic acid molecules form extensive hydrogen bonds with water molecules.

- 5 1.00 mol of gaseous molecules of a compound **A**, takes up a volume of 39 dm^3 when subjected to a pressure of 1.52 atm at a temperature of 70°C .

Which of the following statements explain the above observation?

- 1 Gaseous molecules of **A** experiences strong intermolecular forces of attractions.
- 2 Gaseous molecules of **A** have a significant molecular volume.
- 3 Gaseous molecules of **A** are in constant, rapid, random motion.

- | | |
|----------------|----------------|
| A 1, 2 and 3 | C 2 and 3 only |
| B 1 and 2 only | D 1 only |

- 6 **P**, **Q** and **R** are 3 consecutive elements in Period 3 of the Periodic Table.

- **R** has the highest melting point out of the 3 elements.
- The chloride of **P** gives a solution that is least acidic in water as compared to chlorides of **Q** and **R**.
- The 3rd ionisation energy of **Q** is much lower than that of **P**.

What can **P**, **Q** and **R** be?

- | | |
|--------------|-------------|
| A Na, Mg, Al | C Al, Si, P |
| B Mg, Al, Si | D Si, P, S |

- 7 Which one of the following statements about Group 2 elements and their compounds is correct?

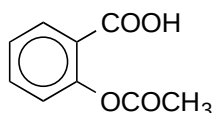
- A Calcium hydroxide has a higher solubility than magnesium hydroxide.
- B Calcium reacts with barium chloride to give calcium chloride.
- C Strontium carbonate, on heating over a short period of time, decomposes to give more carbon dioxide gas than magnesium carbonate.
- D Magnesium has a lower melting point than strontium.

- 8 10 cm³ of gaseous C_xH_yO_z was burnt in excess oxygen. There was a contraction of 20 cm³. When the gaseous mixture was passed through aqueous sodium hydroxide, there was a further contraction of 30 cm³. All gas volumes were measured at room temperature and pressure.

Which one of the following could be C_xH_yO_z?

- | | |
|---|---|
| A C ₃ H ₂ O ₃ | C C ₃ H ₆ O ₂ |
| B C ₃ H ₄ O ₄ | D C ₃ H ₈ O ₂ |

- 9 Aspirin is a medication used to treat pain, fever or inflammation.

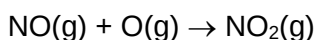


Aspirin

25.0 cm³ of 1.00 mol dm⁻³ NaOH was added to 25.0 cm³ of solution containing aspirin. This resulting solution required 35.20 cm³ of 0.325 mol dm⁻³ HCl to be fully neutralised.

What is the concentration of aspirin in the original 25.0 cm³ solution?

- | | |
|-------------------------------------|-------------------------------------|
| A 0.229 mol dm ⁻³ | C 0.458 mol dm ⁻³ |
| B 0.271 mol dm ⁻³ | D 0.542 mol dm ⁻³ |
- 10 Nitrogen monoxide, NO, is a pollutant that is formed in car exhausts and it can be oxidised as follows:

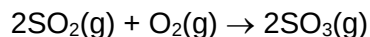


What is the enthalpy change of the above reaction given the following information?



- | | |
|------------------------------------|------------------------------------|
| A -94 kJ mol ⁻¹ | C -552 kJ mol ⁻¹ |
| B -305 kJ mol ⁻¹ | D -589 kJ mol ⁻¹ |

- 11** A key step in the production of sulfuric acid is the oxidation of $\text{SO}_2(\text{g})$ to $\text{SO}_3(\text{g})$.



At 25 °C, $\Delta G = -142 \text{ kJ mol}^{-1}$, $\Delta H = -198 \text{ kJ mol}^{-1}$, $\Delta S = -188 \text{ J K}^{-1} \text{ mol}^{-1}$.

Assuming ΔH and ΔS are constant with temperature, which of the following statements about this reaction are correct?

- 1 The reaction becomes less spontaneous with increasing temperature.
- 2 The reaction becomes spontaneous at 780 °C.
- 3 The reaction is spontaneous at 900 °C.

- A** 1, 2 and 3
B 1 and 2 only
C 2 and 3 only
D 1 only

- 12** An experiment was carried out to investigate the initial rate of reaction between ammonium peroxodisulphate, $(\text{NH}_4)_2\text{S}_2\text{O}_8$, an oxidising agent, and potassium iodide, KI.

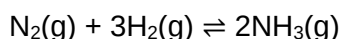
The initial concentrations of the $(\text{NH}_4)_2\text{S}_2\text{O}_8$ and KI solutions in the mixture together with the time taken for the mixture to darken for the various experimental runs are given below.

initial concentration of $(\text{NH}_4)_2\text{S}_2\text{O}_8$ / mol dm^{-3}	initial concentration of KI / mol dm^{-3}	time taken to darken / s
0.10	0.20	35
0.05	0.20	70
0.10	0.067	105
0.02	0.75	?

What is the expected time taken (in s) to darken when the experiment is repeated using initial concentrations of $(\text{NH}_4)_2\text{S}_2\text{O}_8$ and KI to be 0.02 mol dm^{-3} and 0.75 mol dm^{-3} respectively?

- A** 40 **B** 47 **C** 60 **D** 72

- 13** Ammonia is a raw material used in the manufacture of fertilisers, explosives and cleaning fluids. It is produced in the Haber process as shown:



- A closed system initially containing 2.00 mol of nitrogen, 6.00 mol of hydrogen, and 2.40 mol of ammonia at 448 °C is allowed to reach equilibrium in a sealed vessel of volume 1 dm³. At equilibrium, there was 2.32 mol of nitrogen present.
- The vessel is subsequently expanded to 2 dm³ under constant temperature, and equilibrium re-established.

Which of the following statements about this reaction are correct?

- 1 The equilibrium constant, K_c , is $3.96 \times 10^{-3} \text{ mol}^{-2} \text{ dm}^6$.
- 2 The equilibrium will shift to the left when vessel is expanded to double its initial volume.
- 3 The equilibrium concentration of $\text{NH}_3(\text{g})$ is lower after the second equilibrium is established.

- | | |
|-----------------------|-----------------------|
| A 1, 2 and 3 | C 2 and 3 only |
| B 1 and 2 only | D 1 only |

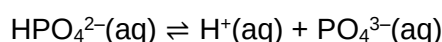
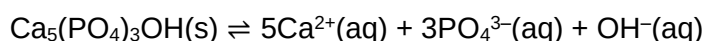
- 14** Common chlorine bleach is typically a 5 % sodium hypochlorite, NaClO solution.

A solution, made by adding solid NaClO to 2 dm³ of water, has a pH of 10.5.

How many moles of NaClO was added to the water, given that chloric(I) acid, HClO has a K_a of $3.03 \times 10^{-8} \text{ mol dm}^{-3}$ at 25 °C?

- | | | | |
|-------------------|-------------------|-------------------|-------------------|
| A 0.25 mol | B 0.31 mol | C 0.55 mol | D 0.62 mol |
|-------------------|-------------------|-------------------|-------------------|

- 15** Hydroxyapatite, $\text{Ca}_5(\text{PO}_4)_3\text{OH}$, is the main constituent of tooth enamel. In the presence of saliva, which contains a buffer system, the following equilibria exist:



Which one of the following statements does **not** help to explain why tooth enamel is dissolved more readily when saliva is acidic?

- A The phosphate ion PO_4^{3-} accepts H^{+} .
- B The hydroxide ions are neutralised by the acid.
- C The calcium ions can precipitate to form $\text{Ca}(\text{OH})_2$.
- D The concentration of PO_4^{3-} decreases in this medium.

- 16** A solution contains three anions with the following concentrations:

anion	concentration / mol dm ⁻³
CrO ₄ ²⁻	0.20
CO ₃ ²⁻	0.10
Cl ⁻	0.010

A dilute AgNO₃ solution is slowly added to the solution.

Which is the first compound to precipitate and what concentration of Ag⁺ is necessary to begin its precipitation?

[Given: K_{sp} (Ag₂CrO₄) = 1.2×10^{-12} mol³ dm⁻⁹, K_{sp} (Ag₂CO₃) = 8.1×10^{-12} mol³ dm⁻⁹, K_{sp} (AgCl) = 1.8×10^{-10} mol² dm⁻⁶]

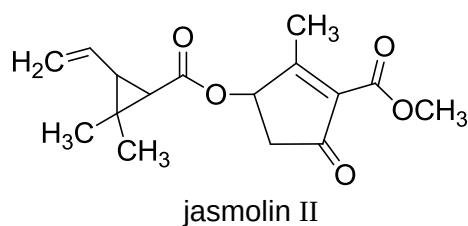
	first ppt	[Ag ⁺] to begin precipitation / mol dm ⁻³
A	Ag ₂ CrO ₄	6.00×10^{-12}
B	Ag ₂ CrO ₄	2.45×10^{-6}
C	Ag ₂ CO ₃	9.06×10^{-6}
D	AgCl	1.80×10^{-8}

- 17** Species with the molecular formula CH₃ can act as an electrophile, a free radical or a nucleophile depending on the number of outer shell electrons on the central carbon atom.

How many outer shell electrons must be present for CH₃ to act in these different ways?

	as an electrophile	as a free radical	as a nucleophile
A	6	7	8
B	6	8	7
C	7	6	8
D	8	7	6

- 18** Pyrethrins such as jasmolin II, are a group of natural compounds synthesised by flowers of the genus Chrysanthemum to act as insecticides.



How many stereoisomers are there for a molecule of jasmolin II?

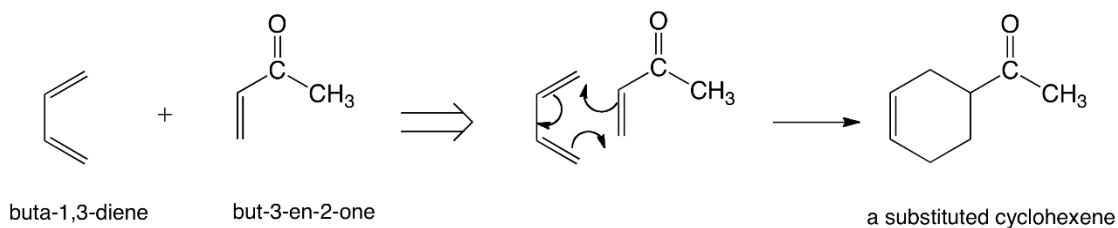
- A** 2 **B** 4 **C** 8 **D** 16

- 19** Compound **X** has molecular formula C_4H_{10} . **X** reacts with $Cl_2(g)$ in the presence of sunlight to produce only two different monosubstituted products. Both of these products give the same Compound **Y**, and no other organic products, when they are reacted with hot ethanolic KOH.

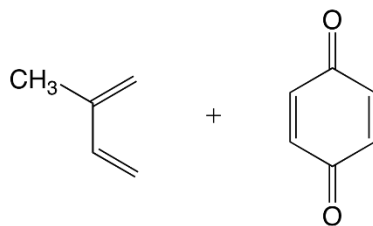
What is produced when **Y** is treated separately with hot acidified dichromate(VI) and cold alkaline manganate(VII)?

	hot acidified dichromate(VI)	cold alkaline manganate(VII)
A	CO_2 and $CH_3CH_2CO_2H$	$CH_2(OH)CH(OH)CH_2CH_3$
B	CO_2 and CH_3COCH_3	CH_3CO_2H only
C	$CH_2=CHCH_2CH_3$	$CH_2(OH)CH(OH)CH_2CH_3$
D	$CH_2=CHCH_2CH_3$	CO_2 and $CH_3CH_2CO_2H$

- 20** The Diels-Alder reaction is an organic reaction between a conjugated diene and a substituted alkene to form a substituted cyclohexene system. One such reaction between buta-1,3-diene and but-3-en-2-one is shown below:



What would be the product formed when the following diene and substituted alkene reacts in a 1:1 ratio?



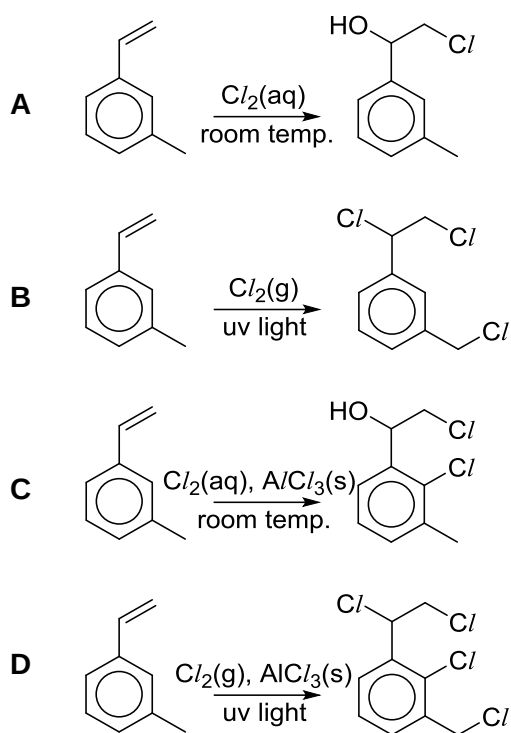
- A**

C

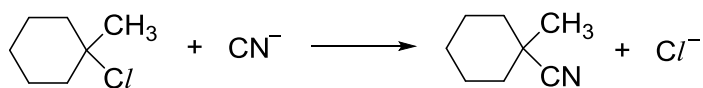
B

D

- 21 Which one of the following products is **unlikely** to be formed based on the given reagents and conditions?

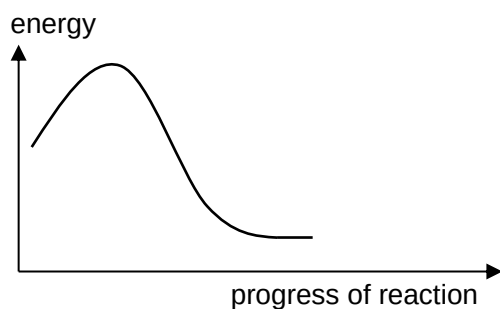


- 22 The reaction between 1-chloro-1-methylcyclohexane and alcoholic potassium cyanide is shown below:



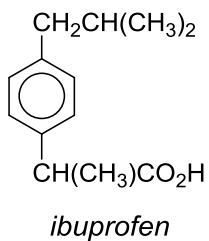
Which of the following statements regarding the reaction are likely to be true?

- 1 The rate equation of the reaction is overall first order.
- 2 The same mechanism will occur less readily if 1-chloro-1-methylhexane is used.
- 3 The energy profile diagram of the reaction is as shown below:

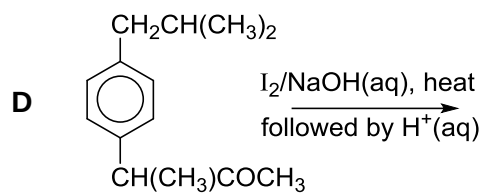
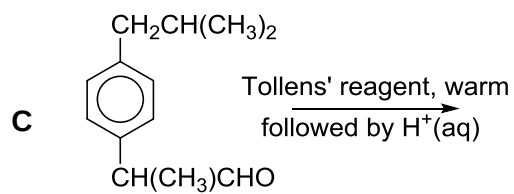
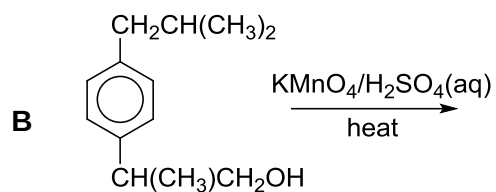
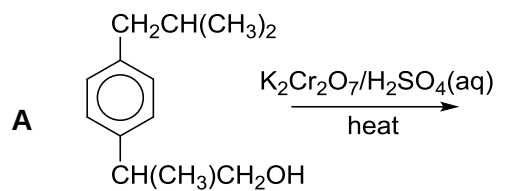


- | | |
|----------------|----------------|
| A 1, 2 and 3 | C 2 and 3 only |
| B 1 and 2 only | D 3 only |

23 *Ibuprofen* is an anti-inflammatory drug.

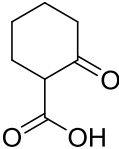
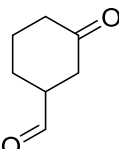
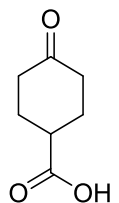


Which one of the following reactions is **unlikely** to lead to its formation?



- 24 When compound **V** is first treated with an excess of a reducing agent, followed by heating with excess concentrated sulfuric acid, it gives **only one** final product with the molecular formula C_7H_{10} .

Which of the following options show a possible structure of compound **V** and the reducing agent?

	compound V	reducing agent
1		H_2/Ni
2		$NaBH_4$
3		$LiAlH_4$

- A 1 and 2 only
 B 2 and 3 only
 C 1 only
 D 3 only
- 25 The acid dissociation constants of ethanoic acid, peroxyethanoic acid, and ethanol are given in the table below.

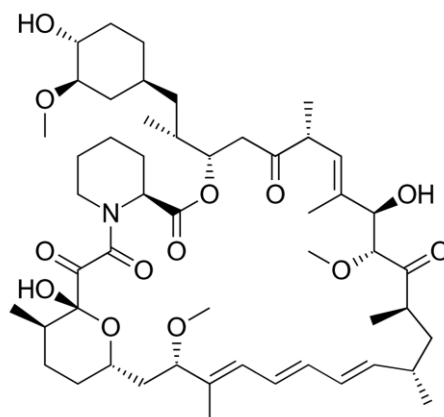
name	formula	pK_a
ethanoic acid	CH_3CO_2H	4.8
peroxyethanoic acid	CH_3CO_3H	8.2
ethanol	CH_3CH_2OH	15.9

Which one of the following statements can best be inferred from the information given above?

- A CH_3CO_3H can react with $Na(s)$ but not with $NaOH(aq)$.
 B The K_b of the three conjugate bases decrease in the following order:
 $CH_3CO_2^- > CH_3CO_3^- > CH_3CH_2O^-$
 C The negative charge on $CH_3CO_2^-$ is less dispersed due to a smaller number of electron-withdrawing O atoms as compared to $CH_3CO_3^-$.
 D The negative charge on $CH_3CO_2^-$ is stabilised by delocalisation of electrons over the $C=O$ group but the negative charge on $CH_3CO_3^-$ is not.

26 Use of Data Booklet is relevant to this question.

The drug *Sirolimus* is used for treatment after kidney transplants.



Sirolimus

The reaction between *Sirolimus* and hot aqueous hydrochloric acid yields an equimolar mixture of two organic products.

What is the relative molecular mass of the nitrogen-containing organic product?

- A** 129.0 **B** 164.5 **C** 165.5 **D** 179.5

27 Use of Data Booklet is relevant to this question.

The calomel electrode was used extensively as a reference electrode in the past. However, it has since been superseded by safer options such as the silver/silver chloride electrode and the standard hydrogen electrode (S.H.E.).

Calomel electrode: $\frac{1}{2}\text{Hg}_2\text{Cl}_2 + \text{e}^- \rightleftharpoons \text{Hg} + \text{Cl}^-$

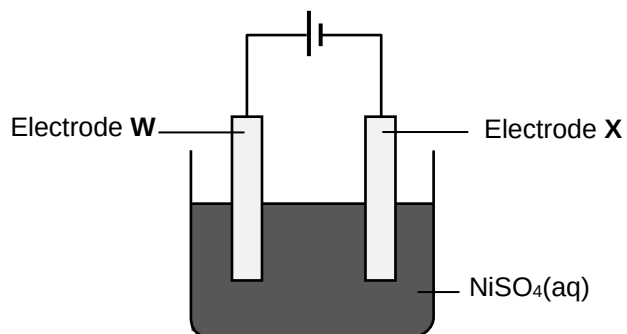
When measured with reference to the calomel electrode, a half-cell containing Zn^{2+}/Zn has a change in Gibbs' free energy of +199 kJ per mole of Zn^{2+} .

What is the standard electrode potential of the calomel electrode?

- A** +0.27 V **B** +1.30 V **C** -1.79 V **D** -2.82 V

28 Use of Data Booklet is relevant to this question.

An electrolytic cell is set up to obtain pure nickel from a nickel–chromium alloy.



The mass of the anode changes by 25 g during the process.

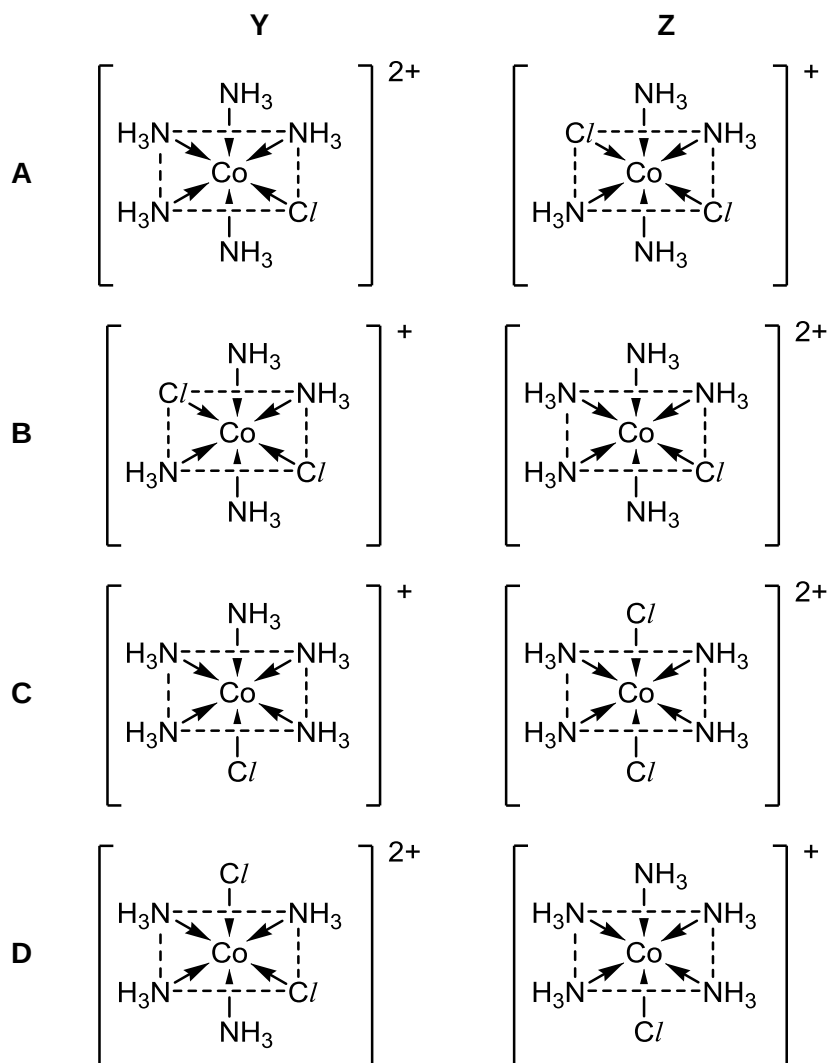
Which one of the following statements best describes the electrolysis process?

- A** The mass of the cathode changes by 25 g during the process.
- B** Chromium can be collected as anode sludge at the end of the process.
- C** Electrode **W** is pure nickel and electrode **X** is nickel–chromium alloy.
- D** The concentration of $\text{Ni}^{2+}(\text{aq})$ in the electrolyte will decrease during the process.

- 29 Two different complexes, **Y** and **Z**, can be obtained when aqueous cobalt(III) chloride undergoes ligand-exchange reaction with ammonia.

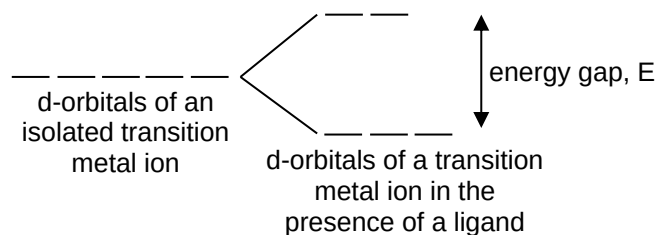
complex	co-ordination number	overall dipole moment	mole of AgCl ppt. per mole of complex
Y	6	yes	2
Z	6	no	1

Which one of the following is likely to be the correct cationic structures of **Y** and **Z**?



30 Use of Data Booklet is relevant to this question.

The following diagram shows how the d-orbitals are split in an octahedral environment.



Some transition metal ions exhibit the ability to change their electronic configuration from a 'high spin' state to a 'low spin' state.

In a 'high spin' state, the electrons occupy all the d-orbitals singly first, before starting to pair up in the lower energy d-orbitals.

In a 'low spin' state, the lower energy d-orbitals are first filled, by pairing up if necessary, before the higher energy d-orbitals are used.

Which one of the following transition metal ions is likely to be able to exhibit both spin states?

A Cu^{2+}

B Cr^{3+}

C Fe^{3+}

D Ni^{2+}

VICTORIA JUNIOR COLLEGE
2017 JC2 PRELIMINARY EXAMINATIONS
H2 CHEMISTRY PAPER 1 ANSWERS

1	B	6	B	11	B	16	D	21	C	26	C
2	B	7	A	12	B	17	A	22	B	27	A
3	A	8	D	13	A	18	C	23	B	28	D
4	D	9	D	14	D	19	C	24	D	29	A
5	C	10	B	15	C	20	A	25	D	30	C