ACJC solutions for H2 Chemistry Prelim Paper 1 2022

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

1 Which species deflects the most in an electric field?

A ⁷Li+

B ²⁴Mg²⁺

C ³²S²⁻

D ²⁷A*l*³⁺

Answer: A

	⁷ Li+	²⁴ Mg ²⁺	³² S ²⁻	²⁷ A <i>l</i> ³⁺
charge	1	1	1	1
mass	7	12	16	9

Angle of deflection $\propto \frac{\text{charge}}{\text{mass}}$

2 The shape of each p-orbital is represented as two lobes.

How many 3d orbitals have four lobes?

A 2

- **B** 3
- **C** 4
- **D** 5

Answer: C



- 3 Which species has the greatest number of unpaired electrons in its ground state?
 - A Cu⁺
 - **B** CH₃⁻
 - C Mg
 - D F

Answer: D

Cu⁺: $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10}$ (no unpaired electrons) CH₃⁻: no unpaired electrons Mg: $1s^2 2s^2 2p^6 3s^2$ (no unpaired electrons) F: $1s^2 2s^2 2p^5$ (1 unpaired electron)

4 Which species contains a dative bond?



D 2 only

Answer: A



5 Which option correctly describes the shape and polarity of the species?

	species	shape	polarity
Α	AlCl ₃	trigonal planar	polar
В	SiF ₄	square planar	non-polar
С	BrF₃	trigonal pyramidal	polar
D	BeCl ₂	linear	non-polar

Answer: D

	species	shape	polarity
Α	A/Cl ₃	trigonal planar (3 b.p.)	non-polar
В	SiF₄	tetrahedral (4 b.p.)	non-polar
С	BrF_3	T shaped (3 b.p. + 2 l.p.)	polar
D	BeCl ₂	Linear (2 b.p.)	non-polar

6 Which graph shows the behaviour of a fixed mass of an ideal gas at a constant temperature?

[p = pressure, V = volume, M_r = molar mass, ρ = density]





- 7 Which statements explain the difference in ionic radius between Na⁺ and F⁻?
 - Outermost electrons of F⁻ experience weaker nuclear charge than those of Na⁺.
 - 2 Outermost electrons of Na⁺ experience greater shielding effect than those of F⁻.
 - 3 Outermost electrons of Na⁺ are nearer to the nucleus than those of F⁻.
 - A 3 only
 - B 1 and 2 only
 - C 1 and 3 only
 - **D** 1, 2 and 3

Answer: C

Statement 1: Correct. F^- contains fewer protons compared to Na⁺. Statement 2: Incorrect. Valence electrons of Na⁺ experience the same shielding effect as those of F^- as both species contain the same number of inner shell electrons. Statement 3: Correct. Valence electrons of Na⁺ are nearer the nucleus than those of F^- , resulting in a smaller ionic radius.

8 0.1 mol of compound **X** dissolves in 1 dm³ of water to give a solution with a pH of 1.

What is the identity of X?

- A AlCl₃
- B CH₃COC*l*
- $\boldsymbol{C} \qquad NH_4NO_3$
- D CH₃COOH

Answer: B

 $\begin{array}{l} AlCl_3: AlCl_3 \ (g) \rightarrow Al^{3+} \ (aq) + 3Cl^- \ (aq) \\ [Al(H_2O)_6]^{3+} + H_2O \rightleftharpoons [Al(H_2O)_5(OH)]^{2+} + H_3O^+ \ (pH > 1) \\ CH_3COCl + H_2O \rightarrow CH_3COOH + HCl \\ HCl \ dissociates \ completely \ to \ give \ a \ [H^+] \ of \ 0.1 \ moldm^{-3}. \ CH_3COOH \ contributes \\ negligible \ H^+ \ to \ the \ solution \ as \ it \ is \ a \ weak \ acid \ and \ its \ dissociation \ is \ suppressed \ by \\ the \ strong \ acid. \ pH = 1 \\ NH_4NO_3(s) \rightarrow NH_4^+(aq) + NO_3^-(aq) \\ NH_4NO_3 \ dissolves \ in \ water \ to \ give \ NH_4^+ \ and \ NO_3^-. \ NH_4^+ \ hydrolyses \ in \ water \\ NH_4^+ + H_2O \rightleftharpoons NH_3 + H_3O^+ \ (pH > 1) \end{array}$

 $CH_3COOH + H_2O \rightleftharpoons CH_3COO^- + H_3O^+ (pH > 1)$

9 Wüstite, containing both Fe^{2+} and Fe^{3+} ions, has the formula $Fe_{20}O_x$. Fe^{2+} constitutes 90% of the iron ions present in the compound.

What is the value of x?

- **A** 18
- **B** 19
- **C** 21
- **D** 22

Answer: C

Total charge on iron ions: $(18 \times 2) + (2 \times 3) = +42$ Total charge on iron ions = Total charge on oxide ions 42 = 2xx = 21

- **10** Which option involves a positive entropy change?
 - A The homolytic fission of gaseous chlorine.
 - **B** The lattice energy of sodium chloride.
 - **C** The contraction of an ideal gas at a constant temperature.
 - D Cooling a copper strip from 373 K to 273 K.

Answer: A

A: There is an increase in the number of gaseous particles as the reaction proceeds.

 $Cl_2(g) \rightarrow 2Cl(g)$

- **B:** $Na^+(g) + Cl^-(g) \rightarrow NaCl(s)$ There is a decrease in the number of gaseous particles.
- **C:** Gas particles have fewer ways of arrangement with a smaller volume.
- **D:** Cooling a metal results in less disorder as the particles vibrate less. In addition, there are fewer energy quanta available for distribution so there are fewer ways to distribute them in the metal.
- 11 The reaction between NO and Br₂ is proposed to proceed via the following mechanism:

Step 1: NO + $Br_2 \rightleftharpoons NOBr_2$ (fast)

Step 2: NOBr₂ + NO \rightarrow 2NOBr (slow)

Which statements are correct?

- NOBr₂ is a radical.
- **2** The rate equation for this reaction is rate = $k[Br_2][NO]^2$.
- 3 NOBr₂ is a transition state.
- A 1 and 2 only
- **B** 1, 2 and 3
- C 1 and 3 only
- D 2 and 3 only

Answer: A

Statement 1: Correct. There is one unpaired electron on the N atom in the molecule. Statement 2: Correct.

From the slow step,

Rate =
$$k$$
[NOBr₂][NO] --- (1)
From step 1, $K_c = \frac{[NOBr_2]}{[NO][Br_2]}$
[NOBr] = K_c [NO][Br₂] --- (2)
Sub. (2) into (1), Rate = $k(K_c$ [NO][Br₂])[NO]
= k' [NO]²[Br₂]
Incorrect NOBr₂ is an intermediate as it app

Statement 3: Incorrect. NOBr₂ is an intermediate as it appears in the reaction mechanism but does not appear in the overall equation.

- **12** Which statement regarding catalysts is correct?
 - **A** Catalysts change the ΔH value of a reaction.
 - **B** Catalysts increase the yield of product in a reaction.
 - **C** Catalysts provide a different mechanism for a reaction.
 - **D** Catalysts change the K_c value of a reaction.

Answer: C

- A: Catalysts do not change the reactants and products of a reaction. Hence the ΔH value remains unchanged.
- **B:** Catalysts do not change in the position of equilibrium in a reaction. Hence the yield of the product does not change.
- **C:** Catalysts reduce the activation energy of a reaction by providing an alternative mechanism for the reaction to proceed by.
- **D**: The rate constant values of both the forward and backward reaction are changed to the same extent by a catalyst. Hence the K_c value of a reaction remains unchanged.
- **13** In aqueous solution, an equilibrium is established between chromate, CrO_4^{2-} (yellow) and dichromate ions, $Cr_2O_7^{2-}$ (orange).

$$2CrO_4^{2-}(aq) + 2H^+(aq) \rightleftharpoons Cr_2O_7^{2-}(aq) + H_2O(I)$$

Which statement regarding the ions and the equilibrium is correct?

- **A** The oxidation number of chromium in both chromium-containing ions is different.
- **B** The difference in colour between CrO_4^{2-} and $Cr_2O_7^{2-}$ is due to a difference in energy gap between the 3d orbitals.

C The
$$K_c$$
 expression for the equilibrium is $K_c = \frac{[Cr_2O_7^{2-}][H_2O]}{[CrO_4^{2-}]^2[H^+]^2}$.

D Increasing the pH turns the solution yellow.

Answer: D

A: Cr is in the same oxidation number of +6 for both species. Let x be the oxidation number of Cr. x + 4(-2) = -2

2x + 7(-2) = -2x = +6 (Cr₂O₇²⁻)

 $x = +6 (CrO_4^{2-})$

- **B:** There are no electrons in the 3d subshell for both chromium-containing species. Hence the difference in colour is not due to the difference in energy gap between the 3d orbitals.
- **C:** The K_c expression for the equilibrium is $K_c = \frac{[Cr_2O_7^{2-}]}{[CrO_4^{2-}]^2[H^+]^2}$. [H₂O] is not included

in the expression as it is a solvent and its concentration remains constant.

D: Increasing the pH results in a decrease in [H⁺]. Position of equilibrium shifts to the left and the major species in solution is CrO₄²⁻.

14 Nitrogen dioxide dimerises in a closed system and establishes the following equilibrium:

 $2NO_2(g) \rightleftharpoons N_2O_4(g)$

When 46.0 g of NO₂ was introduced into an evacuated rigid vessel with an initial pressure 2 atm at constant temperature, the apparent M_r value of the equilibrium mixture is 64.4.

What is the K_p value of this equilibrium?

A 0.281

- **B** 0.556
- **C** 0.778
- **D** 1.11

Answer: C

Amount of NO₂ = $\frac{46}{46}$ = 1 mol

Let x be the mole fraction of NO_2 .

46x + 92(1-x) = 64.4

x = 0.6

	2NO ₂ (g)	\rightarrow	N ₂ O ₄ (g)				
I / mol	1		0				
C / mol	-2y		+y				
E / mol	1-2y		У				
n⊤ = 1−y							
$\frac{1-2y}{1-y} = 0.6$							
y = 0.2857							
n _T = 1 – 0.285	57 = 0.7143						
$\frac{p_1}{p} = \frac{p_2}{p}$							
$\frac{2}{1} = \frac{p_2}{0.7143}$							
p ₂ = 1.429							
$K_{\rm p} = \frac{0.4 \times 1.4}{(0.6 \times 1.4)}$	$\frac{429}{429)^2} = 0.778$						

15 Which solution will solid silver phosphate, Ag₃PO₄, be the least soluble in, at 25 °C?

The numerical value of $K_{sp}(Ag_3PO_4)$ is 8.89×10^{-17} .

- A pure water
- B 2.0 mol dm⁻³ AgNO₃(aq)
- **C** 2.0 mol dm⁻³ NH₃(aq)
- **D** 2.0 mol dm⁻³ K₃PO₄(aq)

Answer: B

Let the solubility of Ag₃PO₄ be *s* mol dm⁻³ $K_{sp} = \lceil Ag^+ \rceil^3 \lceil PO_4^{3-} \rceil$

A:
$$K_{sp} = (3s)^3 (s) \Rightarrow 27s^4 = K_{sp}$$

 $s = \sqrt[4]{\frac{K_{sp}}{27}} = 4.26 \times 10^{-5}$

B:
$$K_{sp} = (3s+2)^3 (s) \approx 2^3 s$$

 $s = \frac{K_{sp}}{8} = 1.11 \times 10^{-17}$

C: $\operatorname{Ag}^{+} + 2\operatorname{NH}_{3} \rightarrow \left[\operatorname{Ag}(\operatorname{NH}_{3})_{2}\right]^{+}$

Formation of complex increases solubility of Ag₃PO₄ as the concentration of Ag⁺ decreases.

D:
$$K_{sp} = (3s)^3 (s+2) \approx (3s)^3 2$$

 $s = \sqrt[3]{\frac{K_{sp}}{54}} = 1.18 \times 10^{-6}$

16 In an acid-base titration, 0.10 mol dm⁻³ solution of an acid is added to 25 cm³ of 0.10 mol dm⁻³ solution of a base.

The pH value of the solution is plotted against the volume, V, of acid added as shown in the diagram.



Which statement is incorrect?

- A Maximum buffering capacity occurs at V = 12.5 cm³.
- **B** The pair of solutions could have been HCI(aq) and $CH_3NH_2(aq)$.
- **C** Methyl orange is a suitable indicator for the above titration.
- When concentration of acid is doubled, the pH at equivalence point remains unchanged.

Answer: D

A: pH at equivalence point < 7; implies presence of acidic salt. Hence strong acid-weak base titration has occurred. When a strong acid is added to the weak base, an acidic salt is formed (conjugate acid of the weak base). As the conjugate acid is present together with the weak base in the solution, a buffer is formed. The solution is at its maximum buffering capacity at half the volume needed for complete neutralisation of the base. Option A is correct.

B: 25 cm³ of base required 25 cm³ of acid at equivalence point. As the concentrations of both solutions are the same, it indicates that the stoichiometry of acid:base is 1:1, hence the solutions involved should be a monoprotic base and a monobasic acid.

Since the equivalence point occurs at pH < 7, it indicates that the salt is acidic and that the base is used in the titration is a weak base. Option B is correct.

C: For strong acid-weak base titration, methyl orange is a suitable indicator as the equivalence point lies below 7 and coincides with the working range of the indicator (approximately 3 to 4). Option C is correct.

D: When the concentration of the acid is doubled, the amount of salt formed at equivalence point is the same, though total volume of the solution is now lower.

Compared to [salt]_{original} = 25.0 x 0.1 / (25 + 25) = 0.05 mol dm⁻³ [salt]_{new} = 12.5 x 0.2 / (12.5 + 25) = 0.0667 mol dm⁻³ So [H⁺] = $\sqrt{K_a \times [salt]}$

when [salt] is higher, new [H⁺] be higher, hence new equivalence pH will decrease.

17 Some vegetable oils contain 'trans fats' that are associated with undesirable increases in the amount of cholesterol in the blood. In the structures below, R_1 and R_2 are different hydrocarbon chains.

Which structure correctly illustrates an optically active 'trans fat'?





Answer: B





trans with one chiral carbon (correct)



cis with one chiral carbon

18 A hydrocarbon reacted with bromine under suitable conditions to give the following product.



What type of reaction occurred between the hydrocarbon and bromine?

- A Electrophilic addition
- **B** Free radical substitution
- **C** Electrophilic substitution
- D Nucleophilic addition

Answer: B

A hydrocarbon can react with bromine via free radical substitution (alkane), electrophilic addition (alkene) or electrophilic substitution (typically occurs on the benzene ring). Nucleophilic addition is not possible as it typically occurs across the carbonyl functional group.

Given that the position of Br atoms are on carbon atoms numbered 1 and 3 relative to each other, this cannot be electrophilic addition as the Br atoms are added across the C=C bond such that they are bonded to carbon atoms numbered 1 and 2 relative to each other.

19 Ferulic acid is an antioxidant that occurs widely in plants.

Assume that CH₃O- group is inert.





Which statements about ferulic acid are true?

- 1 It decolourises aqueous bromine.
- 2 It is not very soluble in water but dissolves in aqueous NaOH.

<mark>3</mark>

HO-CH=CHCH₂OH

It can be prepared from CH_3O K₂Cr₂O₇(aq)

using hot acidified

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

Answer: D

- 1 The alkene functional group in ferulic acid undergoes electrophilic addition with aqueous bromine while the phenol group undergoes electrophilic substitution with aqueous bromine to give a white precipitate.
- 2 Although ferulic acid forms hydrogen bonding with water, it is not very soluble in water due to the benzene ring which is only able to form id id interactions with water.

The -COOH group undergoes acid-base with NaOH(aq) to form $-COO^-$ which increases the compounds solubility in water due to the formation of more favourable ion-dipole interactions with water. Similarly, the phenol group undergoes acid-base reaction with NaOH(aq) to give the phenoxide ion with forms ion-dipole interactions with water.

3 Primary alcohol will be oxidised to the carboxylic acid functional group.

20 Unsaturated carbonyl compounds can undergo a useful reaction known as the Diels-Alder reaction with a diene. An example is shown below.



A student reacted the following diene and carbonyl compound together in a Diels-Alder reaction.



Which product will not be formed?









Answer: B



(note the position of the methyl group)



21 Deuterium, D, is a heavy isotope of hydrogen. Deuteriobenzene reacts with chlorine and $AlCl_3$ under controlled condition so that only monochlorination takes place.

Assuming that the carbon-deuterium bond is broken as easily as a carbon-hydrogen bond, what is the proportion of 2-chlorodeuteriobenzene in the mono-chlorinated products?



Answer: C

Α

The Cl^+ electrophile can be substituted at the H atoms or the D atom.

Thus it can be at the 2^{nd} position with respect to D or 3^{rd} position with respect to D or the 4^{th} position with respect to D





Substituting at position 2 and 6 wrt D will give the same 1,2 product and substitution at 3 and 5 wrt D will give the same 1,3 product

Substituting at position 4 will give the 1,4 product.

Since deuterium atom D can also be substituted (as C-D bond is equally likely to break as stated in the question), chlorobenzene can also be obtained as a product.

Since there is a total of 6 carbons that can be substituted and 2 out of the 6 carbons substituted gives 2-chlorodeuteriobenzene, the % of 2-chlorodeuteriobenzene is 2/6 x 100 = 33.3%

22 Two female sex hormones are oestrone and oestradiol.



2 LiAlH₄ in dry ether 3



1

Answer: A

Option 1 (Correct)

 $SOCl_2$ reacts with the secondary alcohol group in oestradiol to give white fumes of HC*l*. Oestrone does react with $SOCl_2$.

Option 2 (Correct)

Ketone group in oestrone reacts with 2,4-DNPH to form an orange ppt. Oestradiol will not react.

Option 3 (Wrong)

While LiA/H₄ reacts with the ketone group in oestrone and not with oestradiol, there are no visible changes occurring during the reaction which allow for both compounds to be distinguished.

- **23** Many different compounds have been used in aerosol sprays, refrigerators and in making foamed plastics. Which compound will cause the most ozone depletion?
 - A CC*l*₃F
 - B CH₂FCHC*l*F
 - C CH₃CH₂CH₂CH₃
 - D CH₂=CHCI

Answer: A

Ozone depletion is caused by CFCs (i.e. compounds which contain Cl and F) Options C is eliminated.

C-C*l* bonds are weaker than C-F bonds. Hence Option A will form more C*l* radicals than Option B, and cause more ozone depletion.

For Option D, the C-Cl bond is very strong as the p orbital of the Cl will overlap with the pi electron cloud of the C=C bond. Hence the Cl radical will not be produced.

24 Which reagent reacts with the following organic compound to give **only** one organic product?

Assume that CH₃O– group is inert.



- A hot NaOH(aq)
- **B** hot acidified K₂CrO₇(aq)
- **C** H₂(g), Pt
- D HCl(g)

Answer: C

Α	hot NaOH(aq)	В	hot acidified potassium dichromate(VI)
	hydrolyses the ester to give two organic products.		Acid is present. It hydrolyses the ester to give two organic products. The primary alcohol fragment undergoes further oxidation to give carboxylic acid
C	hydrogen in platinum	D	HC <i>l</i> (g)
	add H ₂ across C=C (reduction) to give only one organic product		HCI is added across the C=C double bond to form 2 possible products.

25 The amino acids glutamine and glutamic acid can react with each other to form amide linkages.



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



Answer: B

Possible combinations:

Glutamine Glutamic acid	-NH ₂	-CO ₂ H	
-NH ₂	×	\checkmark	∴ 3 different compounds can be
-CO ₂ H (1)	\checkmark	×	Tormed
CO ₂ H (2)	\checkmark	×	

26 0.01 mol of KIO_n reacts with 0.05 mol of KI stoichiometrically to produce I_2 under acidic conditions.

In this reaction, all the iodine containing reactants were converted to $I_2(aq)$.

What is the value of n?

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

Answer: C $IO_n^-: I^-$ 1 : 5 $[O]: 2I^- \longrightarrow I_2 + 2e^ 5I^- \longrightarrow \frac{5}{2}I_2 + 5e^ [R]: IO_n^- + 2nH^+ + (2n-1)e^- \longrightarrow I_2 + nH_2O$ 2n-1 = 5n = 3

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

By considering relevant E° values, which metal will not dissolved in 1 mol dm⁻³ HC*l*(aq)?

Α	V	B	Ag	С	Mg	D	Sn
---	---	---	----	---	----	---	----

Answer: B

 $2H^+$ + $2e^- \rightarrow H_2$ $E_{red}^{\circ} = 0.00V$

To determine whether metal will not dissolve in HCl(aq), $E_{cell}^{e} < 0$. This will indicate the reaction is non-spontaneous.

Equation	Eoxi ^e	Overall equation	E _{cell} e<0
$V^{2+} + 2e^- \rightarrow V$	-1.20	$V + 2H^{\scriptscriptstyle +} \rightarrow H_2 + V^{2+}$	+1.20
$Ag^+ + e^- \rightarrow Ag$	+0.80	$Ag + 2H^+ \rightarrow H_2 + Ag^+$	-0.80
$Mg^{2+} + 2 e^{-} \rightarrow Mg$	-2.38	$Mg + 2H^{\scriptscriptstyle +} \rightarrow H_2 + Mg^{2+}$	+2.38
$Sn^{2+} + 2 e^{-} \rightarrow Sn$	-0.14	$Sn + 2H^+ \rightarrow H_2 + Sn^{2+}$	+0.14

Hence, Ag cannot dissolve in HCl(aq).

28 The Kolbe reaction involves decarboxylative dimerisation of carboxylate ions by electrolysis. When an aqueous solution of sodium carboxylate is electrolysed, the overall equation is as follows:

 $2RCO_2Na + 2H_2O \rightarrow R-R + 2CO_2 + 2NaOH + H_2$

where $R = CH_3$, C_2H_5 etc.

Which statements about the anode and cathode are correct?

	anode				<u>cathode</u>			
1	The solution around the anode turns moist blue litmus red.				The solution around the cathode turns moist red litmus blue.			
2	RCO ₂ Na is oxidised to R–R at the positive terminal.				H_2O is reduced to H_2 at the negative terminal.			
3	The standard electrode potential involving H_2O is the least positive.				The standard ele involving H ₂ O is	ectrod the m	e potential ost positive.	
A	1 only	В	1 and 2 only	С	2 and 3 only	D	1, 2 and 3	

Answer: A

Option 1 (correct)

Anode: CO_2 produced at the anode is acidic in solution and will turn moist blue litmus red. Cathode: OH^- produced at the cathode is basic and will turn moist red litmus blue.

Option 2 (Incorrect)

Anode: RCO_2Na (oxidation number is +3) is oxidised to CO_2 (oxidation number is +4) at the anode, not to R–R where the oxidation number of C is +3 as well. Cathode: H_2O (oxidation number is +1) is reduced to H_2 (oxidation number is 0) at the cathode.

Option 3 (Incorrect)

 $E(O_2/H_2O) > E(RCO_2^-/CO_2).$ Thus RCO_2^- is selectively oxidised at the anode. $E(H_2O/H_2) > E(Na^+/Na).$ Thus H_2O is selectively reduced at the cathode.

29 15.7 g of the metal gadolinium (Gd) was deposited in electrolysis by a current of 5.0 A for 96.5 minutes.

What is the formula of the gadolinium ion? $[A_r \text{ of } Gd = 157]$

Α	Gd⁺	В	Gd ²⁺	C	Gd ³⁺	D	Gd4+

Answer: C

Q = It = (5)(60)(96.5) = 28950C = (28950/96500) F = 0.3F No. of moles of Gd = 15.7/157 = 0.1 Gdⁿ⁺ + n e⁻ → Gd Quantity of electricity required to deposit 0.1 mol of Gd = 0.3F no. of mol of electrons: no. of mol of Gd = 0.3: 0.1 n = 3 Thus, formula of Gd ion is Gd³⁺. **30 X** is a transition metal. Under a high concentration of C*L*, the cation of **X** forms a coloured complex ion, $[\mathbf{X}Cl_4]^{2-}$. When $[\mathbf{X}Cl_4]^{2-}$ is reduced to $[\mathbf{X}Cl_2]^{-}$, the solution turns colourless.

What is the ground state electronic configuration of X?

A [Ar] $3d^5 4s^1$ **B** [Ar] $3d^{10} 4s^1$ **C** [Ar] $3d^5 4s^2$ **D** [Ar] $3d^9 4s^2$

Answer: B

Solution turns colourless \Rightarrow no d-d transition took place, electronic configuration of d subshell is either d⁰ or d¹⁰.

In $[\mathbf{X}Cl_4]^{2-}$, oxidation number of X is +2. In $[\mathbf{X}Cl_2]^-$, oxidation number of X is +1. Since X⁺ is $[Ar]3d^{10}$ (cannot be $3d^0$ because if X⁺ is [Ar], then X is $[Ar]3d^1$, Sc, which is not a transition metal), X is $[Ar]3d^{10}4s^1$.