H2 P1 REVIEW

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

1 Answer: **A**

Angle of deflection α charge/mass

Option A : 2/4 = 0.5

Option B : 1/19 = 0.05

Option C : 1/28 = 0.036

Option D : 2/32 = 0.06

2 Answer: **C**

Cu: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}4s^1$

Mn: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ 4s^2$

Fe: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^6\ 4s^2$

Fe^{2+}: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^6$

3 Answer: **B**

Option A : $[F\ ---\ H - F\ ]^-$. There is hydrogen bond formed between H in HF and F^- as indicated by ---.

Option B : Both compounds have hydrogen bonding between molecules. However, volatility depends on the electron cloud size (inferred from M_r) which affects the strength of id-id.

Option C : 2-nitrophenol can form intramolecular hydrogen bonding giving rise to less extensive H bonding between molecules and lower melting point.

Option D : Ethanoic acid can dimerise in benzene by forming two H bonds between two acid molecules.

4 Answer: **B**

A simple molecular solid should have a lower melting point (due to weak intermolecular forces) and does not conduct electricity (due to lack of mobile charge carriers – ions or free electrons). It may be soluble or insoluble in water depending on the type of intermolecular forces that it can form with water.

Since the unknown compound is a solid at room temperature, the answer cannot be A due to the melting point.

5 Answer: **C**

Option 1 has a dative bond from O to C while option 3 has a dative bond from N to O. Option 2 has no dative bond present.

6 Answer: **B**

Vol of original gas mixture = 10 + 50 cm^3

Vol of residual gas = ¼ x 60 = 15 cm^3

Vol of unreacted O_2 = 15 cm^3

Vol of reacted O_2 = 50 – 15 = 35 cm^3

$C_xH_y + (x + y/4)O_2 \longrightarrow xCO_2 + y/2\ H_2O$

10 35

$x + y/4 = 35/10$

$4x + y = 14$

$x = 2, y = 6$

7 Answer: **D**

A: 17 + 4(8) + 1 = 50 e

B: 2 + 16 + 4(8) = 50 e

C: 16 + 4(8) + 2 = 50 e

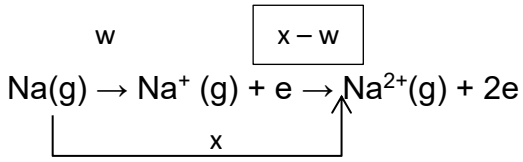
D: 50 – 2 = 48 e

8 Answer: **B**

During thermal decomposition, heat is absorbed to the reaction, so the reaction is endothermic (option A or B).

The activation energy is twice that of the enthalpy change, so option A is incorrect.

9 Answer: **B**



10 Answer: **C**

Rate = k[L][N] = k[L]^2[M]

1: incorrect as Units for k = mol dm^{-3} s^{-1} / (mol dm^{-3})^3 = mol^{-2} dm^6 s^{-1}.

2: correct as adding up the 3 elementary steps gives 2L + N → 2P

3: correct. Catalyst is consumed first then regenerated at the end of the reaction while an intermediate is produced and consumed at the end of the reaction.

11 Answer: **D**

Rate = k[**W**][**X**]^2

Using run 1 data, 0.0064 = k(0.02)(0.015)^2,

k = 1420

12 Answer: **A**

Using pV = nRT

101000(400x10^{-6}) = n(8.31)(300)

n = 0.0162 mol

A_r of gas = 40.1 (Ar)

13 Answer: **D**

Option D: By Le Chatelier's principle, when the experiment is conducted at a lower temperature, the position of equilibrium will shift to the right to release heat as forward reaction is exothermic (mole fraction of I_2(g) should be lower).

Option A: Incorrect as catalyst only speeds up the reaction (equilibrium reached in shorter time), there should not be changes in composition (mole fraction of I_2(g) should remain the same).

Option B: Incorrect as the mole fraction of I_2(g) at time = 0 is the same (0.5) as the first experiment.

Option C: Incorrect as change in pressure does not affect the equilibrium position.

14 Answer: **A**

Options C and D: Incorrect as first IE of X is greater than that of Y, X should be above Y in the Periodic Table.

Option B: Incorrect. Since phosphorus has simple molecular structure, the melting point of P is lesser than aluminium which has giant metallic structure.

15 Answer: **B**

$E^{\ominus}(Cl_2/Cl^-)$ = + 1.36 V

$E^{\ominus}(Br_2/Br^-)$ = + 1.07 V

$E^{\ominus}(I_2/I^-)$ = + 0.54 V

Option A: Chloride ion is less readily oxidised and thus chloride ions are weaker reducing agent.

Option B: $E_{cell}^{\ominus} = E_{red}^{\ominus} - E_{ox}^{\ominus} = +1.07 - 1.36 < 0 \Rightarrow$ reaction is not feasible

Option C: A yellow precipitate that is <u>insoluble</u> (not partially soluble) in aqueous ammonia is formed when <u>iodide</u> (not iodine) is added to silver nitrate solution.

Option D: Incorrect. When one drop of manganate(VII) is added to bromide, <u>manganate(VII) decolourises and orange aqueous bromine</u> is formed.

16 Answer: **B**

Ionic product of ZnS = Ionic product of CuS = $[M^{2+}][S^{2-}]$

= $(0.1)(10^{-35}) = 10^{-36}$ mol^2 dm^{-6}

For ZnS, ionic product < $K_{sp} \Rightarrow$ No ppt observed

For CuS, ionic product > $K_{sp} \Rightarrow$ Ppt observed (Option B is correct)

$H_2S \rightleftharpoons 2H^+ + S^{2-}$ — (1)

$M^{2+}(aq) + S^{2-}(aq) \rightleftharpoons MS(s)$ — (2)

When pH is lowered, $[H^+]$ is increased, by LCP, position of equilibrium (1) shifts to the left. $[S^{2-}]$ decreases. Thus position of equilibrium (2) shifts to the left and MS(s) dissolves (less ppt formed).

17 Answer: **C**

As the equivalence pH is less than 7, this is a reaction between strong acid (HCl) and weak base (NH_3).

$[NH_3] = \frac{20 \times 0.1}{10}$ = 0.2 mol dm^{-3}

18 Answer: **C**

At 25 °C, $[H^+] = [OH^-] = 10^{-7}$ mol dm^{-3}

pH = –log $[H^+]$ = 7

$K_w = [H^+][OH^-] = 10^{-14}$ mol^2 dm^{-3}

pK_w = -lg K_w = 14

K_a of $H_2O = \frac{[H^+][OH^-]}{[H_2O]} = \frac{10^{-14}}{55.6}$ = 1.80 x 10^{-16} mol dm^{-3}

pK_a = –lg K_a = 15.7 (Statement 1 is incorrect)

pH < pK_w < pK_a (Statement 2 is correct)

When temperature increases, by Le Chatelier's Principle, position of equilibrium shifts right to absorb heat since forward reaction is endothermic. $[H^+]$ and $[OH^-]$ will increase and K_w will increase and pK_w will decrease. (Statement 3 is correct)

19 Answer: **D**

A $CH_2=C=CHCH_3$ contains one sp hybridised and one sp^3 hybridised C atoms.

B $CH_2=CHCN$ contains one sp hybridised C atom but no sp^3 hybridised C atoms.

C $HOCH_2C{\equiv}CH$ contains two sp hybridised and one sp^3 hybridised C atoms.

D $CH_3CH_2CH=CHCN$ contains one sp hybridised and two sp^3 hybridised C atoms.

20 Answer: **C**

The reaction involves breaking of C–X bond to release free X^- ions which can then combine with Ag^+ ions to form a precipitate of AgX.

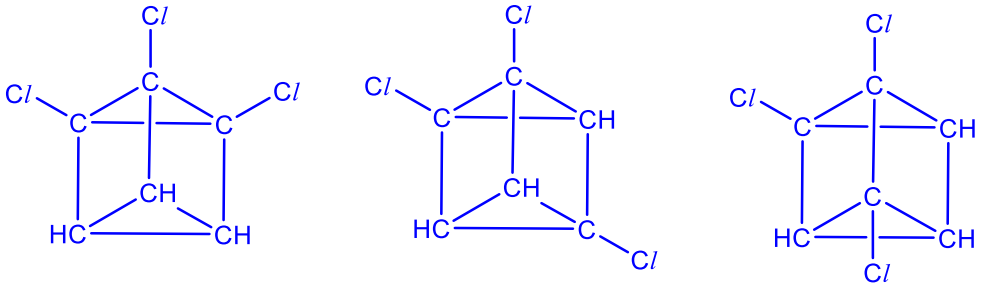
The rate of reaction depends on the strength of C–X bond.

The time taken to observe precipitate for compound 1, 2 and 3 depends on strength of C–C*l*, C–Br and C–I respectively and independent of C–F bond.

Since C–I bond is the weakest of the three bonds, it is the easiest to break and will take the shortest time for the formation of precipitate.

Since C– C*l* bond is the strongest of the three bonds, it is the hardest to break and will take the longest time for the formation of precipitate.

21 Answer: **A**



22 Answer: **B**

Step 1 is electrophilic substitution (Friedel Crafts alkylation) using halogenoalkane, $(CH_3)_3CCl$.

Step 2 involves converting benzene to cycloalkane hence this is reduction (inferred from gain of H).

Step 3 involves formation of ester from either the use of CH_3COOH, warm with conc. H_2SO_4 or CH_3COCl.

23 Answer: **B**

1. The ring contains more than 8 carbon atoms hence the C=C bond in the ring can exhibit cis-trans isomerism.

Statement 1 is correct.2.

The alkene functional group can react with Br_2 via electrophilic addition reaction. However, the molecular formula of the product should be $C_{17}H_{30}OBr_2$ not $C_{17}H_{32}OBr_2$ as only Br atoms are added across the C=C bond and there should be no change in number of H atoms.

Statement 2 is incorrect.

3. Civetone does not exhibit intermolecular hydrogen bonding since there are no H atoms directly bonded to F, O or N atoms in the molecule.

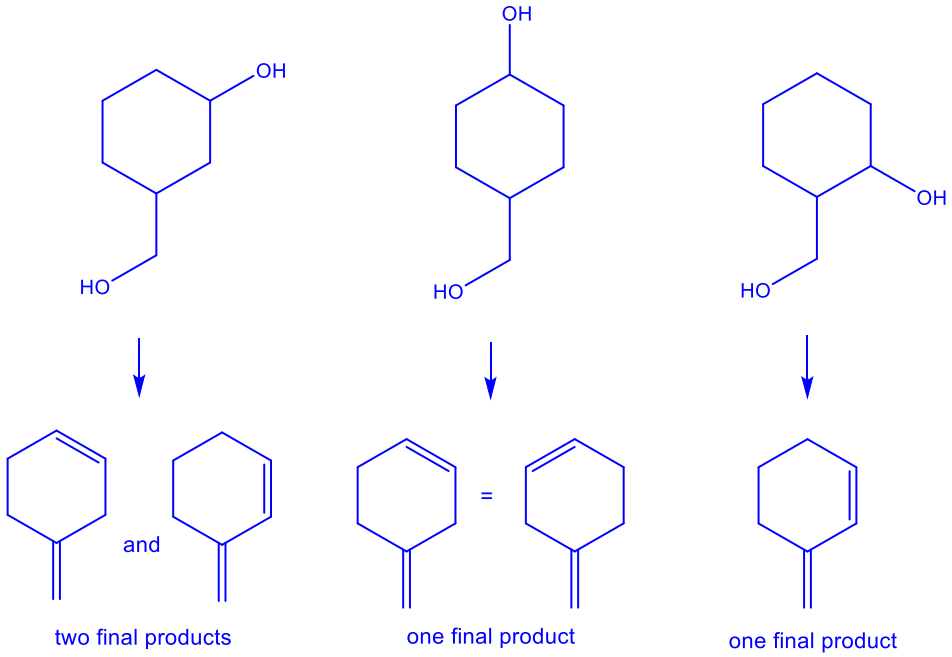
The dominant type of intermolecular forces should be permanent dipole-permanent dipole and instantaneous dipole-induced dipole attractions.

Note: the presence of O atom in civetone can still allow it to form hydrogen bonding with other types of molecules.

Statement 3 is correct.

24 Answer: **C**

The three compounds undergo elimination to form alkenes.



Only one of the compounds can form two final products with molecular formula C_7H_{10}.

25 Answer: **D**

A: Incorrect. $-NH_2$ group is 2- and/or 4- directing and polysubstitution will occur with $Br_2(aq)$ to give 2,4,6-tribromophenylamine instead.

B: Incorrect as –Br is 2- and/or 4- directing. Hence in the first step, the NO_2^+ will be directed to the 2nd or 4th position with respect to the –Br group, instead of the 3rd position.

C: Incorrect. While $-NO_2$ is 3-directing, the LiA/H_4 will reduce the nitrobenzene to other compounds (not phenylamine) instead.

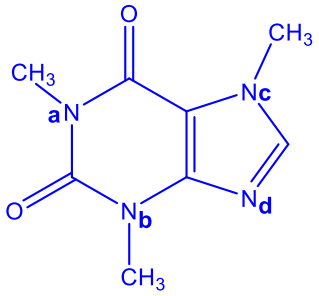
26 Answer: **C**

A: Incorrect. $NaBH_4$ only reduces ketones and aldehydes but there is no carbonyl functional group in the caffeine molecule. The amides in the caffeine molecule can only be reduced by $LiAlH_4$ in dry ether.

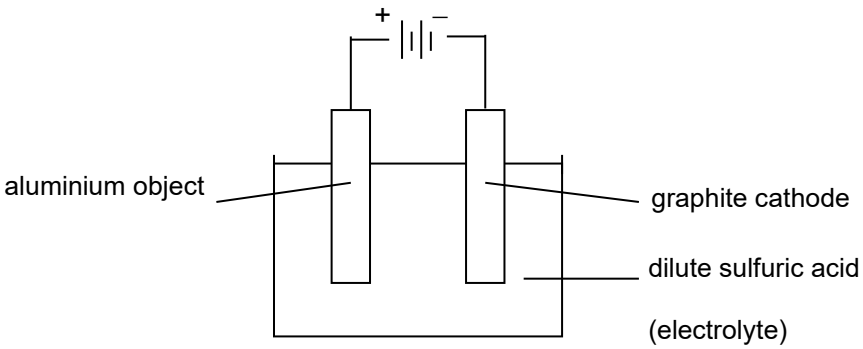
B: Incorrect. The amides and tertiary amine do not undergo condensation with ethanoyl chloride. Hence HCl gas is not formed.

C: Correct. The amide groups in the caffeine molecule can undergo alkaline hydrolysis to give CH_3NH_2 which is an alkaline gas.

D: Incorrect. 1 mole of caffeine reacts with 1 mole of HCl(aq) at room temperature via an acid-base reaction. The amide groups in the caffeine molecule are neutral as the lone pair of electrons on Na and Nb are delocalised over the O-C-O bond and not available to form a dative covalent bond with a proton. The lone pair of electrons on Nc are delocalised in the ring and not available to form a dative covalent bond with a proton. Only Nd is basic and can react with HCl(aq) as the lone pair of electrons on Nd is not delocalised and available for donation to a proton.



27 Answer: **D**



Option A: Incorrect. The aluminium object to be coated is placed at the anode.

Option B: Incorrect. At the graphite cathode:

Reduction: $2H^+(aq) + 2e^- \rightarrow H_2(g)$

Option C: Incorrect. Anodising is the process of increasing the thickness of the Al_2O_3 layer of aluminium objects through electrolysis.

Option D: Correct.

Oxidation: $2\ Al(s) + 3\ H_2O(l) \rightarrow Al_2O_3(s) + 6H^+(aq) + 6e^-$

0.01 mol of Al_2O_3 formed would require 0.06 mol of electrons.

$Q = It = n_eF$

$I = \frac{0.06 \times 96500}{30 \times 60} = 3.2$ A

28 Answer: **A**

$O_2(g) + 4H^+(aq) + 4e^- \rightleftharpoons 2H_2O(l)$ ---(1) $E^\ominus(O_2/H_2O) = +1.23$ V

$S_4O_6^{2-}(aq) + 2e^- \rightleftharpoons 2S_2O_3^{2-}(aq)$ ---(2) $E^\ominus(S_4O_6^{2-}/S_2O_3^{2-}) = +0.09$ V

$E^\ominus_{cell} = E^\ominus(O_2/H_2O) - E^\ominus(S_4O_6^{2-}/S_2O_3^{2-}) = (+1.23) - (+0.09) = +1.14$ V

Option 1: Correct. Adding water will decrease both the $[S_4O_6^{2-}(aq)]$ and $[S_2O_3^{2-}(aq)]$. By LCP, equilibrium position of (2) will shift to the right to increase total ion concentration as there are more ions on the right hand side of the equation. Hence $E(S_4O_6^{2-}/S_2O_3^{2-})$ will be more positive than +0.09 V and E_{cell} will be less positive.

Option 2: Correct. Iodine will react with $S_2O_3^{2-}$, decreasing $[S_2O_3^{2-}(aq)]$. By LCP, equilibrium position of (2) will shift to the right to increase $[S_2O_3^{2-}(aq)]$. Hence $E(S_4O_6^{2-}/S_2O_3^{2-})$ will be more positive than +0.09 V and E_{cell} will be less positive.

Option 3: Correct. Using a lower pressure than 1 bar (standard conditions) will cause equilibrium position (1) to shift left. Hence $E(O_2/H_2O)$ will be less positive than +1.23 V and E_{cell} will be less positive.

29 Answer: **A**

A solution containing $Fe^{3+}(aq)$ ions is yellow.

When NaCN(aq) is added to this solution, CN^- replaces the H_2O ligands in $[Fe(H_2O)_6]^{3+}$ via a ligand exchange and orange red $[Fe(CN)_6]^{3-}$ ions are formed. Hence the solution turns from yellow to orange red.

$[FeF_6]^{3-}$ has a smaller K_{stab} than $[Fe(CN)_6]^{3-}$. Hence, F^- will not be able to replace CN^- in a ligand exchange. Thus, the orange red solution remains orange red.

30 Answer: **B**

Option A: Incorrect. Reaction I is a redox reaction but reaction II is a hydrolysis reaction of $Fe^{3+}(aq)$ ions to give H^+ ions, followed by acid-base reaction between H^+ and CO_3^{2-} ions.

Option B: Correct. Cr^{3+} has a high charge density. $[Cr(H_2O)_6]^{3+}$ can undergo hydrolysis in water to produce H^+ ions, forming effervescence of CO_2 and a grey-green ppt of $Cr(OH)_3$, when CO_3^{2-} ions are added.

Option C: Incorrect. The orange solution contains $Cr_2O_7^{2-}$ ions. ions. Hence Cr^{3+} is oxidised to $Cr_2O_7^{2-}$, and reagent **R** should be an oxidising agent such as H_2O_2. Zn is a reducing agent.

Option D: Incorrect. $EDTA^{4-}$ is a hexadentate ligand. Reaction IV is a ligand exchange where one $EDTA^{4-}$ ligand exchanges for six H_2O molecules. Hence, the number of particles increases and the disorder of the system increases. Thus, ΔS should be positive.

$[Cr(H_2O)_6]^{3+} + EDTA^{4-} \rightleftharpoons [Cr(EDTA)]^- + 6H_2O$