

VICTORIA JUNIOR COLLEGE
2025 JC2 H2 CHEMISTRY PRELIM EXAM

PAPER 1 ANSWERS

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

1 B

species	Bk ²⁺	Fm ³⁺
protons	97	100
neutrons	249 – 97 = 152	252 – 100 = 152
electrons	97 – 2 = 95	100 – 3 = 97

Hence, Fm³⁺ has more electrons than Bk²⁺ but both ions have the same number of neutrons

2 A

According to Hund's rule, electrons will occupy the subshells singly first before pairing up. All the elements in Period 3 have principal quantum 3 as its valence shell. There is 1 orbital for s subshell and 3 orbitals for p subshell.

element	electronic configuration	no. of paired electrons
Na	[Ne]3s ¹	0
Mg	[Ne]3s ²	2
Al	[Ne]3s ² 3p ¹	2
Si	[Ne]3s ² 3p ²	2
P	[Ne]3s ² 3p ³	2
S	[Ne]3s ² 3p ⁴	4
Cl	[Ne]3s ² 3p ⁵	6
Ar	[Ne]3s ² 3p ⁶	8

Total no. of paired electrons
= 0 + 2 + 2 + 2 + 2 + 4 + 6 + 8
= 26

3 C

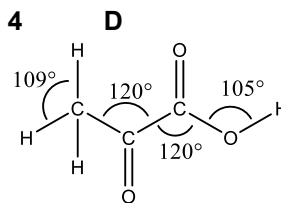
All three molecules have instantaneous dipole-induced dipole and permanent dipole-permanent dipole interactions.

Statement 1 (incorrect): Chlorine is more electronegative than bromine and thus there is a larger electronegativity difference between hydrogen and chlorine than between hydrogen and bromine. Correspondingly, there is a larger overall dipole moment in HCl, which leads to stronger permanent dipole-permanent dipole interactions between molecules of HCl than between molecules of HBr.

Statement 2 (correct): Fluorine has less electrons than bromine. Thus, the total number of electrons in HF is less than that in HBr. This leads to HF having a smaller electron cloud size and less extent of electron cloud polarisation, resulting in weaker instantaneous dipole-induced dipole interactions between HF molecules.

Statement 3 (Correct): Fluorine is more electronegative than chlorine and thus there is a larger electronegativity difference between hydrogen and fluorine than between hydrogen and chlorine. Correspondingly, there is a larger overall dipole moment in HF, which leads to stronger permanent dipole-permanent dipole interactions between molecules of HF than between molecules of HCl.

4



5

B

Option A (incorrect): Only molecules of ideal gases are assumed to have elastic collisions i.e. collisions are associated with no loss of kinetic energy.

Option B (correct): Molecules of both ideal gases and real gases are in constant random motion.

Option C (incorrect): Only molecules of ideal gases are assumed to have no intermolecular forces of attraction.

Option D (incorrect): Molecules of ideal gases only are assumed to have negligible volume (size) compared to the volume (size) of the container.

6

B

Option A (incorrect): A compound containing a hydrogen atom is not necessarily an Arrhenius acid.

Option B (correct): As acetylene is unable to react with water, it is unable to dissociate in water to form H₃O⁺, which is characteristic of an Arrhenius acid.

Option C (incorrect): The conjugate base of acetylene is HC≡C⁻.

Option D (incorrect): A Lewis acid is an electron pair acceptor. Acetylene contains carbon and hydrogen that have full valence electron shells and cannot further accept an electron pair.

7

D

The effectiveness of each of the three minerals as fire retardant is dependent on its **ease of thermal decomposition** to produce CO₂, which smothers the fire. The ease of thermal decomposition of the minerals is dependent on the charge density and hence the polarising power of the respective Group II metal ions (Ba²⁺, Ca²⁺ and Mg²⁺). The order of effectiveness as fire retardant, from best to worst, corresponds to the order of decreasing polarising power of the Group II metal ions: Mg²⁺ > Ca²⁺ > Ba²⁺.

mineral	chemical formula	behaves as a mixture of
dolomite	CaMg(CO ₃) ₂	1 mol of CaCO ₃ & 1 mol of MgCO ₃
huntite	Mg ₃ Ca(CO ₃) ₄	1 mol of CaCO ₃ & 3 mol of MgCO ₃
norsethite	BaMg(CO ₃) ₂	1 mol of BaCO ₃ & 1 mol of MgCO ₃

Huntite is a more effective fire retardant than dolomite as huntite contains more MgCO₃ and hence it produces more CO₂ upon complete thermal decomposition. Dolomite is a more effective fire retardant than norsethite as CaCO₃ has higher ease of thermal decomposition than BaCO₃.

8

A

P₄O₁₀ dissolves in water to give H₃PO₄.

P₄O₁₀, an acidic oxide, reacts with NaOH to give soluble Na₃PO₄.

Even though P₄O₁₀ has no reaction with an acid HCl(aq), it can dissolve in the water present.

9 A

Molecular Formula of G = $C_7H_{12}O_3$
 $C_7H_{12}O_3 + 8.5O_2 \rightarrow 7CO_2 + 6H_2O$

10 B

$$\Delta H_{LE} \propto \frac{q^+ q^-}{r_+ + r_-}$$

Since the charge of cation in $MgCl$ is +1 while that in $MgCl_2$ and $SrCl_2$ is +2, $MgCl$ has the smallest magnitude of lattice energy.

Since ionic radius of Sr^{2+} is larger than that of Mg^{2+} due to additional quantum shell, $SrCl_2$ has a smaller magnitude of lattice energy than that of $MgCl_2$.

[L.E]: $MgCl < SrCl_2 < MgCl_2$

11 A

Statement 1 (correct)

$$\begin{aligned}\Delta H_r^\ominus &= \sum n\Delta H_f^\ominus(\text{products}) - \sum m\Delta H_f^\ominus(\text{reactants}) \\ &= -1273 - [6 \times (-394) + 6 \times (-286)] \\ &= +2807 \text{ kJ mol}^{-1}\end{aligned}$$

Statement 2 (correct): The photosynthesis process has no change in number of particles of gases, but there is a change of state (liquid water in the reactant to solid $C_6H_{12}O_6$ in the product). There is a decrease in overall entropy and thus, ΔS has a negative sign (e.g. less disordered).

Statement 3 (correct): Since $\Delta G = \Delta H$ (+ve) $- T\Delta S$ (-ve), the ΔG for the reaction will always be positive at all temperatures as ΔH and $-T\Delta S$ is always positive.

12 C

Option A (incorrect): Since H^+ is a catalyst, the $[H^+]$ (and hence pH) will not change during the reaction.

Option B (incorrect): To find the order with respect to H^+ , the concentration that needs to be varied (for different sets of experiments) should be $[H^+]$ and not $[CH_3CO_2CH_2CH_3]$.

Option C (correct): This is using the initial rate method.

Option D (incorrect): Since H^+ is a catalyst, the $[H^+]$ (and hence volume of NaOH required) will not change during the reaction.

13 C

Step 2 is the rate-determining step and rate = $k'[CHCl_3][Cl]$.

Since Cl is an intermediate, it cannot be in the rate equation and $[Cl]$ is dependent on $[Cl_2]$ in step 1.

$$K_c = \frac{[Cl]^2}{[Cl_2]} \Rightarrow [Cl] = (K_c)^{1/2} [Cl_2]^{1/2}$$

Thus, rate = $k'[CHCl_3] (K_c)^{1/2} [Cl_2]^{1/2} = k[CHCl_3] [Cl_2]^{1/2}$ where $k = k'(K_c)^{1/2}$.

14 D

Option A & B (correct): Increasing the temperature and adding a catalyst will lead to an increase in rate constant, according to Arrhenius equation. Hence there is a greater proportion of particles having energy greater than the activation energy

Option C (correct): Increase in temperature will lead to an increase in rate constant

Option D (incorrect): Concentration of the reactants affects the rate of reaction but it does not affect the rate constant.

15 B

Statement 1 (correct): pK_a has an inverse relationship with K_a and hence with acid strength. A lower pK_a denotes a stronger acid. $-COOH$ has the lowest pK_a and hence is the most acidic group.

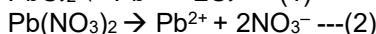
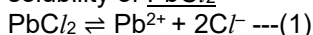
Statement 2 (correct): At pH 8, $-COOH$ and $-SeH$ will mostly be in the deprotonated form while amine will be mostly in the protonated form ($-NH_3^+$). This is because when $pH = pK_a$, the concentration of the protonated and deprotonated form is equal. When $pH > pK_a$, the concentration of the deprotonated is higher than the protonated. When $pH < pK_a$, the concentration of the deprotonated is lower than the protonated. This is based on the formula: $pH = pK_a + \lg \frac{[A^-]}{[HA]}$

Hence, at pH 8, there are 2 negative charge and 1 positive charge in Selenocysteine, giving an overall nett charge of -1 . Selenocysteine will migrate towards the positive terminal.

Statement 3 (incorrect): A change in the concentration of $[H^+]$ at fixed temperature only shifts the position of equilibrium of the dissociation of the acid, but it does not change the value of K_a .

16 A

Option A (correct): Adding $Pb(NO_3)_2$ introduces the common ion Pb^{2+} . By Le Chatelier's Principle, the position of equilibrium of equation (1) shift to the left, decreasing solubility of $PbCl_2$



Option B (incorrect): There is no common ion to reduce the solubility of $AgCl$.

Option C (incorrect): $BaCl_2$ is a highly soluble salt and there is no common ion.

Option D (incorrect): $NaCl$ is a soluble salt while $AgCl$ is a sparingly soluble salt. Although there is a common ion Cl^- , the dissociation of Cl^- from $AgCl$ is low while $NaCl$ is a highly soluble salt, hence the solubility of $NaCl$ will likely not decrease.



17 D

Step 1 is nucleophilic substitution as the alcohol group is replaced by the nucleophile Br^- from HBr .

Step 2 is also a nucleophilic substitution. $(CH_3)_3P$ is a nucleophile (P has a lone pair). Another way to visualise is to link to something you have learnt by replacing P with N. $(CH_3)_3N$ is also a nucleophile.

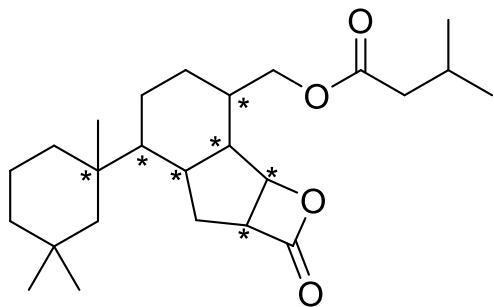
18 D

Statement 1 (correct): The molecular formula of E is $C_{12}H_{10}N_2O_2$ and hence empirical formula is C_6H_5NO . G has the molecular and empirical formula C_6H_5NO .

Statement 2 (correct): The molecular formula of F is $C_{12}H_{10}N_2O_2$. Hence E and F are structural isomers.

Statement 3 (correct): Since $C_{12}H_{10}N_2O_2 = (C_6H_5NO)_2$, M_r of F is twice of G.

19 C



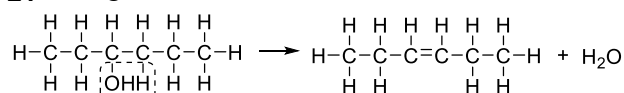
20 D

Option A (incorrect): When $\text{AgNO}_3(\text{aq})$ is added to acyl chloride $\text{COC}l$ at room temp, white ppt of AgCl is seen immediately because acyl chloride undergoes hydrolysis readily, liberating Cl^- . The reaction will be even faster when acyl chloride is first boiled with $\text{NaOH}(\text{aq})$.

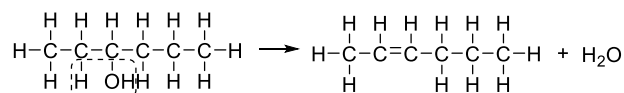
Option B and C (incorrect): $\text{C}_6\text{H}_5\text{Cl}$ and $\text{CH}_3\text{CH}_2\text{CHCHCl}$ will not give white ppt regardless of whether it is treated with $\text{AgNO}_3(\text{aq})$ at room temp or with boiling $\text{NaOH}(\text{aq})$ first. The $\text{C}-\text{Cl}$ bond has partial double bond character and is difficult to cleave.

Option D (correct): Chloroalkane will not give white ppt when treated with $\text{AgNO}_3(\text{aq})$ at room temp. When boiled with $\text{NaOH}(\text{aq})$ first, the $\text{C}-\text{Cl}$ bond will cleave, liberating Cl^- .

21 C



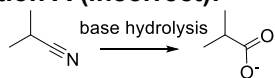
(option B & D)



(option A & D)

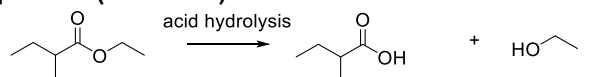
Hence option C is not produced.

22 C

 $(\text{CH}_3)_2\text{CHCH}_2\text{CO}_2\text{H}$ is 3-methylbutanoic acid**Option A (incorrect):**

2-methylpropanitrile

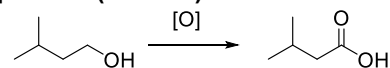
2-methylpropanoic acid

Option B (incorrect):

ethyl 2-methylbutanoate

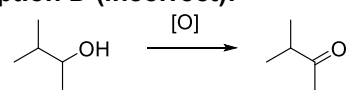
2-methylbutanoic acid

ethanol

Option C (correct):

3-methylbutan-1-ol

3-methylbutanoic acid

Option D (incorrect):

3-methylbutan-2-ol

3-methylbutan-2-one

23 A

The reaction between ethanoyl chloride and ethylamine leads to the formation of an amide. Option 1 describes one of the key bond formed and broken in the course of the reaction.

When ethanoyl chloride is replaced by ethanoic acid, an acid base reaction will take place instead of nucleophilic acyl substitution. So option 2 is incorrect.

The amide formed is neutral and the pH of the solution should therefore be 7. So option 3 is incorrect.

24 A

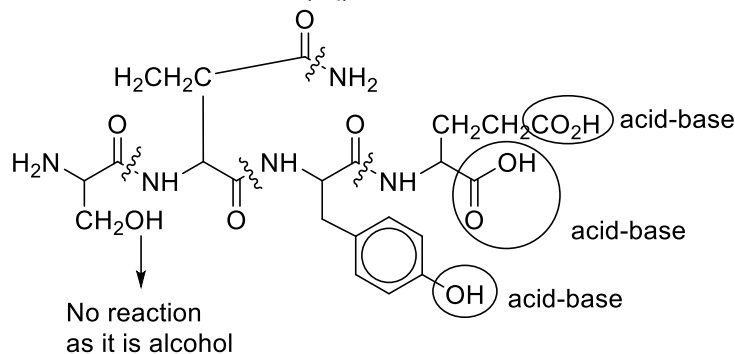
Notice that the aldol reaction is like nucleophilic addition – there is no loss of carbon atoms from reactants to products. The diketone has 7 carbon atoms, it can react with itself via intermolecular or intramolecular reaction. If it is intermolecular reaction – there will be a total of 14 carbon atoms in the product (assuming 2 molecules react).

Option A has only 12 carbon atoms – so cannot be possibly formed.

Option B has 14 carbon atoms, is a possible product based on the reaction pattern.

Options C and D are also possible products formed by intramolecular reaction

25 D

The reactions with $\text{NaOH}(\text{aq})$ are shown below.

Altogether in 1 molecule of T, it would react with 7 $\text{NaOH}(\text{aq})$.

26 B

Arg-Ile

Arg-Ile-Ser-Lys

Ser-Lys-Trp-Ile

Trp-Ile-Lys

Lys-Leu-Arg

Arg-Ile-Ser-Lys-Trp-Ile-Lys-Leu-Arg

27 C

 $\text{Mg}^{2+} + 2\text{e}^- \rightarrow \text{Mg}$ Amount of Mg = $4.8 \div 24.3$

= 0.19753 mol

Amount of electron = 0.19753×2

= 0.39506 mol

 $\text{Cr}^{3+} + 3\text{e}^- \rightarrow \text{Cr}$ Amount of Cr = $0.39506 \div 3$

= 0.13168 mol

Mass of Cr = 0.13168×52.0

= 6.84 g

28 B

 $[\text{O}]: \text{SO}_4^{2-} + 4\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{SO}_2 + 2\text{H}_2\text{O} \quad E^\circ = +0.17 \text{ V}$ $[\text{R}]: \text{VO}_2^+ + 2\text{H}^+ + \text{e}^- \rightleftharpoons \text{VO}^{2+} + \text{H}_2\text{O} \quad E^\circ = +1.00 \text{ V}$ $[\text{R}]: \text{VO}^{2+} + 2\text{H}^+ + \text{e}^- \rightleftharpoons \text{V}^{3+} + \text{H}_2\text{O} \quad E^\circ = +0.34 \text{ V}$ $[\text{R}]: \text{V}^{3+} + \text{e}^- \rightleftharpoons \text{V}^{2+} \quad E^\circ = -0.26 \text{ V}$

For a reaction to occur,

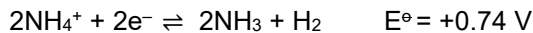
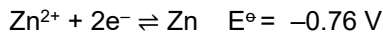
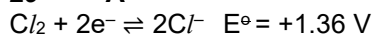
$$E^{\circ}_{\text{cell}} = E^{\circ}_{\text{reduced}} - E^{\circ}_{\text{oxidised}} > 0$$

$$\Rightarrow E^{\circ}_{\text{reduced}} - (0.17) > 0$$

\Rightarrow If $E^{\circ}_{\text{reduced}} > 0.17 \text{ V}$, the reaction will occur.

Hence the final oxidation state of vanadium is +3.

29 A



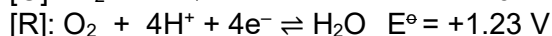
NH_4^+ undergoes reduction ($E^{\circ} = +0.74 \text{ V}$) at the graphite electrode while Zn undergoes oxidation ($E^{\circ} = -0.76 \text{ V}$) at the zinc casing.

$$E^{\circ}_{\text{cell}} = +0.74 - (-0.76) = \underline{\underline{+1.50 \text{ V}}} > 0$$

Since $E^{\circ}_{\text{cell}} > 0$, the reaction is thermodynamically favourable.

Electrons flow from anode (zinc casing), where oxidation takes place, to the cathode (Graphite electrode), where reduction takes place.

30 D



$$E^{\circ}_{\text{cell}} = +1.23 - (1.07) = \underline{\underline{+0.16 \text{ V}}} > 0$$

Statement 1 (correct): Air contains about 21% O_2 , oxygen pressure is smaller than 1 atm. Position of equilibrium for O_2 shifts to the left, resulting in $E_{(\text{O}_2|\text{H}_2\text{O})} < +1.23 \text{ V}$. This will cause the E_{cell} to be less

than 0 and reaction is not spontaneous.

Statement 2 (correct): Reaction could be energetically feasible ($E^{\circ}_{\text{cell}} > 0$), but kinetically not feasible due to high activation energy.

Statement 3 (correct): If $[\text{Br}^-]$ is smaller than 1.0 mol dm^{-3} , position of equilibrium for $\text{Br}_2|\text{Br}^-$ will shift to the left, resulting in $E_{(\text{Br}_2|\text{Br}^-)} > +1.07 \text{ V}$. This will

cause the E_{cell} to be less than 0 and reaction is not spontaneous.