2020 RI H2 Chemistry Prelim Paper 1 – Suggested Solutions

Question	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Answer	C	C	D	A	A	B	D	A	B	C	B	A	B	C	C

Question	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Answer	C	D	D	B	D	A	B	A	D	B	D	C	B	A	D

MCQ worked solutions

Q1 (Ans: C)

$$\frac{28.0 \times m + 25.0 \times 131 + 27.0 \times 132 + 20.0 \times 134}{28.0 + 25.0 + 27.0 + 20.0} = 131.31$$

m = 129

Q2 (Ans: C)

$5\ X^- + XO_n^- \rightarrow$ halogen-containing product (either X_2 or XO^-)

Step 1: Balance X; $5\ X^- + XO_n^- \longrightarrow \underline{3}\ X_2$
OR $5\ X^- + XO_n^- \longrightarrow \underline{6}\ XO^-$

Step 2: Check if amt of electrons gained = amt of electrons lost

Option A	$5\ X^- + XO^- \longrightarrow 3\ X_2$ amt of electrons gained by 1 mol of XO^- to form ½ mol X_2 = 1 mol amt of electrons lost by 5 mol of X^- to form $\frac{5}{2}$ mol of X_2 = 5 mol	not balanced
Option B	$5\ X^- + XO_2^- \longrightarrow 6\ XO^-$ amt of electrons gained by 1 mol of XO_2^- to form 1 mol of XO^- = 2 mol amt of electrons lost by 5 mol of X^- to form 5 mol of XO^-= 10 mol	not balanced
Option C	$5\ X^- + XO_3^- \longrightarrow 3\ X_2$ amt of electrons gained by 1 mol of XO_3^- to form ½ mol X_2 = 5 mol amt of electrons lost by 5 mol of X^- to form $\frac{5}{2}$ mol of X_2 = 5 mol	balanced
Option D	$5\ X^- + XO_4^- \longrightarrow 6\ XO^-$ amt of electrons gained by 1 mol of XO_4^- to form 1 mol of XO^- = 6 mol amt of electrons lost by 5 mol of X^- to form 5 mol of XO^- = 10 mol	not balanced

Q3 (Ans: D)

$n_{total} = n_{Ar} + n_{Xe}$
$P_{total}V_{total}/RT = P_{Ar}V_{Ar}/RT + P_{Xe}V_{Xe}/RT$

At constant T,
$P_{total}V_{total} = P_{Ar}V_{Ar} + P_{Xe}V_{Xe}$
$\mathbf{P} \times (5 + 10) = (150 \times 5) + (350 \times 10)$
P = 283 kPa

At constant V and n, pressure $\propto$ Temperature

$$\frac{600}{283} = \frac{T}{298}$$

T = 632 K

Q4 (Ans: A)

$^{235}_{92}U \rightarrow {}^{96}_{37}Rb + {}^{135}_{55}Cs + 4\ {}^{Z}_{A}X$

$235 = 96 + 135 + 4Z \rightarrow Z = 1$
$92 = 37 + 55 + 4A \rightarrow A = 0$

X is $^{1}_{0}n \Rightarrow$ neutron

Q5 (Ans: A)

Horizontal axis:
P_4O_{10} (pH 3), SiO_2 and Al_2O_3 (pH 7 as they do not dissolve in water), MgO (pH 9)

Vertical axis:
P_4 (simple molecular) < Mg (giant metallic) < Al (giant metallic) < Si (giant covalent)

Q6 (Ans: B)

The graph shows increased solubility in acidic and alkaline solutions
$\Rightarrow$ compound is amphoteric, i.e. $Al(OH)_3$

With acid: $Al(OH)_3(s) + 3HCl(aq) \rightarrow AlCl_3(aq) + 3H_2O(l)$
With base: $Al(OH)_3(s) + NaOH(aq) \rightarrow Na^+[Al(OH)_4]^-(aq)$

Q7 (Ans: D)

Graph shows a sharp decrease in second IE from W to X
$\Rightarrow$ second electron removed from W is from an inner electronic shell
$\Rightarrow$ W is in Group 1

<table>
<tr><td>Statement 1</td><td>Not correct. V is in Group 18. However, if V is helium then U is hydrogen, but hydrogen does not have a second IE.
As such, U to Z must be fluorine to silicon (with atomic numbers less than 20).
<table>
<tr><th>Label</th><th>Group No.</th><th>Identity</th></tr>
<tr><td>U</td><td>17</td><td>F</td></tr>
<tr><td>V</td><td>18</td><td>Ne</td></tr>
<tr><td>W</td><td>1</td><td>Na</td></tr>
<tr><td>X</td><td>2</td><td>Mg</td></tr>
<tr><td>Y</td><td>3</td><td>Al</td></tr>
<tr><td>Z</td><td>4</td><td>Si</td></tr>
</table></td></tr>
<tr><td>Statement 2</td><td>Correct. Group 1 metals (e.g. Na) are more reactive than their adjacent Group 2 metals (e.g. Mg) as Group 1 metals require less energy to form their ions.</td></tr>
<tr><td>Statement 3</td><td>Correct. Aluminium is a better electrical conductor than silicon (which is a semi-conductor)</td></tr>
</table>

Q8 (Ans: A)

Option A	Correct. Down the group, $E^{\ominus}_{M2+/M}$ becomes more negative $\Rightarrow$ tendency of oxidation of M increases $\Rightarrow$ reducing power increases
Option B	Not correct. Electronegativity increases across a Period but <u>decreases</u> down a Group.
Option C	Not correct. Down the Group, the charge of the Group 2 ions remain the same but ionic radii increases. Hence, the magnitude of $\Delta H_{hydration}$ <u>decreases</u>. $\lvert\Delta H_{hyd}\rvert \propto \left\lvert\frac{q}{r}\right\rvert$ q: ionic charge, r: ionic radius
Option D	Not correct. Down the Group, the charge of the Group 2 ions remain the same but ionic radii increases. Hence, the magnitude of lattice energy <u>decreases</u>. $\lvert LE\rvert \propto \left\lvert\frac{q_+ q_-}{r_+ + r_-}\right\rvert$

Q9 (Ans: B)

Option A	Not correct. C1 and C3 are sp^2 hybridised with a trigonal planar shape (three regions of electron density – 3 bond pairs, 0 lone pairs).
Option B	Correct. C2–C3 bond is formed from a sp^2-sp^2 overlap while C4–C5 bond is formed from a sp^2-sp^3 overlap. Since sp^2 orbital has greater s-character than sp^3 orbital, the sp^2-sp^2 overlap is more effective. Hence the C2–C3 bond is a stronger bond and has a shorter bond length.
Option C	Not correct. There are 12 σ bonds in a molecule of penta-1,3-diene. *Note: The C-H bonds are also σ bonds.*
Option D	Not correct. The π electrons are only able to move freely between C1 and C4. This is because C1 to C4 are all sp^2 hybridised and each contain an unhybridised p orbital which allows for continuous p orbital overlap. This allows for the π electrons to move freely (delocalised) within the overlapping p orbitals. C5 is sp^3 hybridised and does not have an unhybridised p orbital.

Q10 (Ans: C)

Option A	Not correct $\Rightarrow$ m.p. of $SiCl_4$ < SiO_2 $SiCl_4$ has a simple molecular structure with weak intermolecular forces of attraction whereas SiO_2 has a giant molecular structure with strong covalent bonds.
Option B	Not correct $\Rightarrow$ m.p. of $NaCl$ < Na_2O Since O^{2-} has a larger charge and smaller radius than Cl^-, Na_2O has stronger ionic bonds (more exothermic LE) than $NaCl$. $$\|LE\| \propto \left\|\frac{q_+ q_-}{r_+ + r_-}\right\|$$
Option C	Correct $\Rightarrow$ m.p. of $NaCl$ > $AlCl_3$ $NaCl$ is an ionic compound with strong ionic bonds whereas $AlCl_3$ is a covalent compound with simple molecular structure and weak intermolecular forces of attraction. (Note: $AlCl_3$ is a covalent compound due to the high polarising power of Al^{3+} and the high polarisability of Cl^-.)
Option D	Not correct $\Rightarrow$ m.p. of *cis*-but-2-ene < *trans*-but-2-ene The molecules of *cis*-isomer pack poorly in the solid lattice because the two bulky methyl groups are located on the same side of the C=C bond. The poor packing results in larger distances between molecules, which lead to weaker intermolecular forces and hence a lower melting point for the *cis*-isomer.

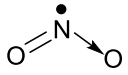
Q11 (Ans: B)

Option A	Not correct. For step Q, $\mathbf{2}Al(g) \longrightarrow \mathbf{2}Al^{3+}(g) + \mathbf{6}e^-$ ΔH = **2** × sum of 1st, 2nd and 3rd IE of *Al* = **2**(577 + 1820 + 2740) = +10274 kJ mol^{-1}
Option B	Correct. For step R, $\mathbf{3}O(g) + \mathbf{6}e^- \longrightarrow \mathbf{3}O^{2-}(g)$ ΔH = **3** × sum of 1st and 2nd electron affinity of oxygen = +2106 kJ mol^{-1} Sum of the first and second electron affinity of oxygen = $\frac{+2106}{3}$ = +702 kJ mol^{-1}
Option C	Not correct. The enthalpy change for step P should be: sum of $2\Delta H^{\ominus}_{atom}(Al)$ and $\underline{\mathbf{3}}\Delta H^{\ominus}_{atom}(O_2)$ (Recall: Standard enthalpy change of atomisation, $\Delta H^{\ominus}_{atom}$, of an element is the energy absorbed to form <u>one mole</u> of <u>gaseous atoms</u> from the element at 298 K and 1 bar.)
Option D	Not correct. Lattice energy = ΔH (step S) = ΔH (step T) – ΔH (sum of steps P + Q + R) It is wrong to ignore the signs of the enthalpy changes by saying that lattice energy of aluminium oxide is the sum of the enthalpy changes in steps P, Q, R and T. A correct statement would be "The magnitude of lattice energy of aluminium oxide (step S) is the sum of the magnitude of the enthalpy changes in steps P, Q, R and T".

Q12 (Ans: A)

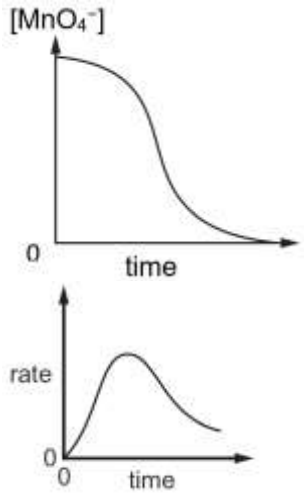
Statement 1	Correct. (1) $C_2H_6(g) + \frac{7}{2}O_2(g) \longrightarrow 2CO_2(g) + 3H_2O(\mathbf{l})$ $\quad \Delta H$ = –1542 kJ mol^{-1} (given) (2) $C_2H_6(g) + \frac{7}{2}O_2(g) \longrightarrow 2CO_2(g) + 3H_2O(g)$ $\quad \Delta H$ = –1434 kJ mol^{-1} (3) $\mathbf{3}H_2O(l) \longrightarrow \mathbf{3}H_2O(g)$ $\quad \Delta H = \mathbf{3}y$ Since eqn (3) = eqn (2) – eqn (1), 3y = –1434 –(–1542) = +108 kJ mol^{-1} y = $\frac{+108}{3}$ = +36 kJ mol^{-1}
Statement 2	Correct. Reaction 2 involves a change of physical state from $H_2O(l) \longrightarrow H_2O(g)$, hence $\Delta G = \Delta H - T\Delta S = 0$ at boiling point, 373 K (phase transition temperature). $\Delta S = \frac{\Delta H}{T} = \frac{y}{373}$ kJ mol^{-1} K^{-1}[a]
Statement 3	Not correct. $\Delta S < 0$ as the number of gaseous particles decreases as reaction 1 proceeds. Since $\Delta G = \Delta H - T\Delta S$ and $\Delta H > 0$, reaction 1 is not spontaneous at all temperatures.

Q13 (Ans: B)

Option A	Correct. NO_2 is a free radical as it contains an <u>unpaired</u> electron. 
Option B	Not correct. A reaction intermediate is a species that is formed in one step of a reaction mechanism and consumed in a subsequent step. Since O is a reactant in step 2, but is not formed in the earlier step, O is <u>not</u> a reaction intermediate.
Option C	Correct. From the rate-determining first step, the rate equation is: rate = k[NO][O_3] Hence, the reaction is overall second order.
Option D	Correct. A homogeneous catalyst is a substance that is in the <u>same phase</u> as the reactants and increases the rate of a reaction without itself undergoing any permanent chemical change (i.e. <u>regenerated</u>). Since NO is in the same phase (i.e. gaseous phase) as the reactant O_3 in step 1, and NO is consumed in step 1 but regenerated in step 2, NO acts as a homogeneous catalyst.

Q14 (Ans: C)

The reaction is an autocatalytic reaction, in which Mn^{2+} acts as the autocatalyst.



(with Mn^{2+} no added)

- Initially, the reaction is slow since it is not catalysed.
- As the Mn^{2+} ions are produced, they increase the rate of the reaction by acting as an autocatalyst.
- Towards the end of the reaction, the concentration of the reactants has fallen to a low level and so the rate of the reaction decreases, even though there is an adequate supply of catalyst.

Hence option 1 is correct and option 2 is not correct.

Since the reaction is first-order with respect to MnO_4^-, rate = k[MnO_4^-] (with Mn^{2+} added). Hence, the graph of rate against [MnO_4^-] is a straight line passing through origin. Option 3 is correct.

Q15 (Ans: C)

When temperature is <u>increased</u>, the <u>rate constants</u>, k, of <u>both</u> the forward and backward reactions <u>increase</u> since $k = Ae^{-Ea/RT}$ (Arrhenius equation).

However, because the forward reaction is exothermic, the rate constant for the forward reaction increases to a smaller extent than the rate constant for the backward reaction when temperature is increased. Hence, the <u>equilibrium constant</u>, K_c or K_p, <u>decreases</u> and the <u>position of equilibrium shifts to the left (favours the backward reaction that absorbs heat)</u>.

Q16 (Ans: C)

K_c (and K_p) expression of heterogeneous equilibrium exclude the concentration (or partial pressure) of pure solids and pure liquids because they are constant at a given temperature. Hence, the removal of some liquid CH_3OH will not change its concentration and has no effect on the position of equilibrium.
$\Rightarrow$ Statement 2 is not correct

Addition of $H_2(g)$ and a decrease in temperature will cause the position of equilibrium to shift to the right, lowering the partial pressure of CO(g).
$\Rightarrow$ Statements 1 and 3 are correct

Q17 (Ans: D)

Aqueous ammonia, being a weak base, undergoes slight ionisation in aqueous solution to give OH^- ions. The precipitate that is formed when NH_3 is added to Mg^{2+} ions is $Mg(OH)_2$.

$NH_3(aq) + H_2O(l) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$ ……..(1)
$Mg^{2+}(aq) + 2OH^-(aq) \rightleftharpoons Mg(OH)_2(s)$ ……..(2)

What happens when solid NH_4Cl is added?

Ammonium salts are soluble in water. NH_4Cl dissociates completely in aqueous solution to give NH_4^+ (a common ion). The increase in $[NH_4^+]$ causes the position of equilibrium (1) to shift to the left. The backward reaction of (1) can also be seen as NH_4^+ acting as an acid (conjugate acid of weak base, NH_3) to react with $OH^- \Rightarrow$ Option D is correct.

As a result, $[OH^-]$ decreases and the position of equilibrium (2) shifts to the left. When ionic product < K_{sp} of $Mg(OH)_2$, the precipitate of $Mg(OH)_2(s)$ dissolves.

Option A is not correct as no soluble complex is formed.
Option B is not correct as solubility product, K_{sp}, only changes with temperature.
Option C is not correct as $MgCl_2$ is a soluble salt and hence the addition of Cl^- does not change $[Mg^{2+}]$.

Q18 (Ans: D)

$CH_3COCOOH \rightleftharpoons CH_3COCOO^- + H^+$

Statement 1	Correct. CH_3COCOO^- is the conjugate base of the weak acid, $CH_3COCOOH$, and is a proton acceptor ($CH_3COCOO^- + H^+ \rightleftharpoons CH_3COCOOH$).
Statement 2	Not correct. This is a strong base-weak acid titration. The marked pH change will occur at pH 7.5 – 10.5, which does not coincide with the pH range of methyl orange (3.2 – 4.4). Instead, thymol blue or thymolphthalein would be suitable indicators.
Statement 3	Not correct. After 5 cm^3 of weak acid is added to 10 cm^3 of NaOH, there are unreacted NaOH and the salt of the weak acid, CH_3COCOO^-, present. This mixture does not constitute a buffer. (Note: If it had been 5 cm^3 of NaOH added to 10 cm^3 of weak acid instead, a buffer at maximum buffering capacity will be formed as there would be equal amount/concentration of unreacted $CH_3COCOOH$ and the salt CH_3COCOO^- present.)

Q19 (Ans: B)

$Cu \longrightarrow Cu^{2+} + 2e^-$
(0.20 g)
To decrease mass of Cu to 0.10 g,
Amount of Cu oxidised = $\frac{0.10}{63.5}$ = 0.001575 mol
Amount of electrons lost = 0.001575 × 2 = 0.00315 mol
$q = n_eF$ =0.00315 × 96500 = 303.9 C
q = It
t = 303.9/3 = 101.3 s = 1.69 min

Q20 (Ans: D)

Statement 1	Correct. The salt bridge completes the circuit through the flow of ions to maintain electrical/charge neutrality.
Statement 2	Not correct. For the electrochemical cell, electrons flow in the external circuit from the anode to the cathode.
Statement 3	Not correct. The two half–cells are connected internally by a salt bridge– a U-tube that contains an electrolytic solution, such as KNO_3, whose ions do not react with other ions in the cell or with electrodes.

Q21 (Ans: A)

The question states that the Zn electrode is the negative electrode when the battery is undergoing discharge. This means that Zn is the anode in the electrochemical cell.

Statement 1	Correct. If Zn is the anode, it should have a more negative electrode potential. Hence x is less negative (or more positive). $E^{\ominus}_{cell} = E^{\ominus}_{cathode} - E^{\ominus}_{anode}$ = x – (–0.76) > 0
Statement 2	Correct. Reduction: $2MnO_2 + H_2O + 2e^- \longrightarrow Mn_2O_3 + 2OH^-$ Oxidation: $Zn \longrightarrow Zn^{2+} + 2e^-$ Overall for battery discharging process: $Zn + 2MnO_2 + H_2O \longrightarrow Zn^{2+} + Mn_2O_3 + 2OH^-$ The charging process is the reverse reaction: $Zn^{2+} + Mn_2O_3 + 2OH^- \longrightarrow Zn + 2MnO_2 + H_2O$
Statement 3	Correct. When the battery is undergoing discharge (an electrochemical cell), the Zn electrode is the anode, where Zn is oxidised to Zn^{2+}. During charging, the polarity/sign of the electrodes are reversed. Zn electrode becomes the cathode, where Zn^{2+} is reduced to reform Zn.

Q22 (Ans: B)

$H_2O_2(aq) + 2H^+(aq) + 2e^- \rightleftharpoons 2H_2O(l)$ $\quad E^\ominus = +1.77$ V (more positive $\rightarrow$ cathode)
$Cr^{3+}(aq) + 3e^- \rightleftharpoons Cr(s)$ $\quad E^\ominus = -0.74$ V (less positive $\rightarrow$ anode)

$E^\ominus_{cell} = E^\ominus(H_2O_2/H_2O) - E^\ominus(Cr^{3+}/Cr)$

Option A	Not correct. Increasing $[Cr^{3+}]$ will cause $E(Cr^{3+}/Cr)$ to become less negative (or more positive) and E_{cell} will decrease.
Option B	Correct. Increasing $[H_2O_2]$ will cause $E(H_2O_2/H_2O)$ to become more positive and E_{cell} will increase.
Option C	Not correct. Adding H_2O will dilute the solution and cause position of equilibrium in H_2O_2/H_2O half-cell to shift to the left to increase the concentration of ions. Hence $E(H_2O_2/H_2O)$ will become less positive and E_{cell} will decrease.
Option D	Not correct. E_{cell} is independent of the surface area of an electrode.

Q23 (Ans: A)

1) To explain the observations of blue ppt, dark blue solution and pale blue solution

<u>When $NH_3(aq)$ is added dropwise:</u>
$NH_3(aq) + H_2O(l) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$
$Cu^{2+}(aq) + 2OH^-(aq) \rightleftharpoons Cu(OH)_2(s)$
blue precipitate

<u>When $NH_3(aq)$ is added in excess:</u>
$Cu(OH)_2(s) + 4NH_3(aq) \rightarrow [Cu(NH_3)_4]^{2+}(aq) + 2OH^-(aq)$
dark blue solution

<u>When $H_2SO_4(aq)$ is added in excess:</u>
$[Cu(NH_3)_4]^{2+}(aq) + 2H^+(aq) + 2H_2O(l) \rightarrow Cu(OH)_2(s) + 4NH_4^+(aq)$
blue precipitate
$Cu(OH)_2(s) + 2H^+(aq) \rightarrow Cu^{2+}(aq) + 2H_2O(l)$
pale blue solution
$\Rightarrow$ Option D is correct, hence not the answer.

2) To explain the formation of pink solid on addition of $Sn^{2+}(aq)$

From the *Data Booklet*:
$\mathbf{[Cu(NH_3)_4]^{2+}} + 2e^- \rightleftharpoons Cu + 4NH_3$ $\quad E^\ominus = -0.05$V
$\mathbf{Cu^{2+}} + 2e^- \rightleftharpoons Cu$ $\quad E^\ominus = +0.34$V
$Sn^{4+} + 2e^- \rightleftharpoons \mathbf{Sn^{2+}}$ $\quad E^\ominus = +0.15$V

$Cu^{2+} + Sn^{2+} \longrightarrow Cu + Sn^{4+}$ $\quad E^\ominus_{cell} = +0.34 - (+0.15) = +0.19$V
Addition of $Sn^{2+}(aq)$ to pale blue solution: Reaction between Cu^{2+} and Sn^{2+} is spontaneous ($E^\ominus_{cell} > 0$) and pink solid Cu is formed.
$\Rightarrow$ Option B is correct, hence not the answer.

$[Cu(NH_3)_4]^{2+} + Sn^{2+} \longrightarrow Cu + Sn^{4+} + 4NH_3$ $\quad E^{\ominus}_{cell} = -0.05 - (+0.15) = -0.20V$
Addition of $Sn^{2+}(aq)$ to dark blue solution: Reaction between $[Cu(NH_3)_4]^{2+}$ and Sn^{2+} is non-spontaneous ($E^{\ominus}_{cell} < 0$) hence the solution remains dark blue.

Note: Cu^{2+} is more easily reduced than $[Cu(NH_3)_4]^{2+}$ and is hence a stronger oxidising agent.
$\Rightarrow$ Option C is correct, hence not the answer

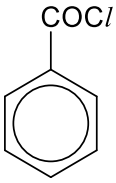
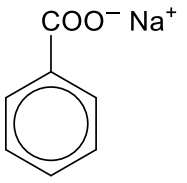
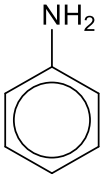
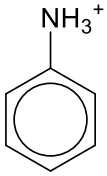
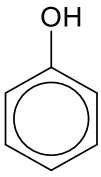
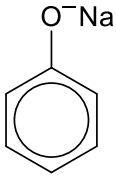
3) To explain how a pink solid is formed from the dark blue solution

$[Cu(NH_3)_4]^{2+}$ $+ 2e^- \rightleftharpoons Cu + 4NH_3$ $\quad E^{\ominus} = -0.05V$
$Sn^{4+} + 2e^- \rightleftharpoons$ **Sn^{2+}** $\quad E^{\ominus} = +0.15V$
There was no spontaneous redox reaction between $[Cu(NH_3)_4]^{2+}$ and Sn^{2+}, but if we have a stronger reducing agent than Sn^{2+} (less positive/more negative $E^{\ominus}$ than $E^{\ominus}([Cu(NH_3)_4]^{2+}/Cu)$ then reduction of $[Cu(NH_3)_4]^{2+}$ can occur.

$Ag^+ + e^- \rightleftharpoons$ **Ag** $\quad E^{\ominus} = +0.80V$
However, since $E^{\ominus}(Ag^+/Ag)$ is more positive than $E^{\ominus}([Cu(NH_3)_4]^{2+}/Cu)$, Ag cannot cause the reduction of $[Cu(NH_3)_4]^{2+}$ to form Cu.
$\Rightarrow$ Option A is not correct, hence is the answer.

Q24 (Ans: D)

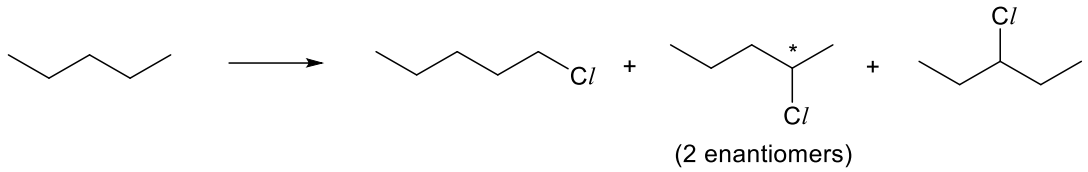
Options A, B and C will result in the formation of ionic salts which are soluble in water due to the formation of favourable ion-dipole interactions.

Option A		and NaOH(aq)	forms	
Option B		and HCl(aq)	forms	
Option C		and NaOH(aq)	forms	

For option D, no reaction will occur between the alcohol and NaOH(aq). Phenylmethanol will form two immiscible layers with water due to its low solubility in water.

(Note: Phenylmethanol is less soluble in water due to its bulky non-polar benzene ring that interferes with the formation of hydrogen bonds between the -OH group and H_2O molecules.)

Q25 (Ans: B)

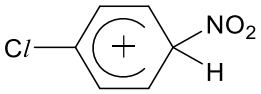


(2 enantiomers)

Total = 1 + 2 + 1 = 4 products

Q26 (Ans: D)

This reaction involves the nitration of chlorobenzene.

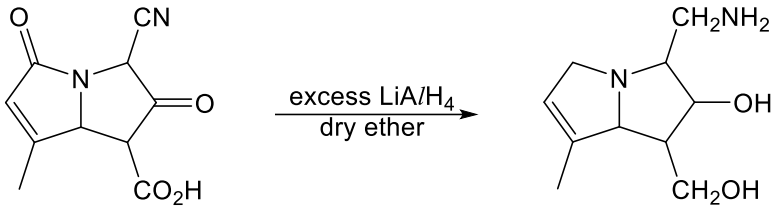
Option A	Not correct. The catalyst is concentrated H_2SO_4.
Option B	Not correct. The intermediate is  (or the 2-isomer).
Option C	Not correct. C*l* is a deactivating group *(refer to the Data Booklet)* which makes the ring less electron rich and less reactive towards electrophilic attack. Thus a higher temperature is required for reaction compared to benzene.
Option D	Correct. The NO_2^+ electrophile is produced from the reaction between conc HNO_3 and conc H_2SO_4.

Q27 (Ans: C)

All three substances are conjugate bases of weak acids. Since the same amount of each substance is dissolved separately in the same volume of water, the higher the pH of the resultant solution, the stronger the base.

Note: The weaker the acid, the stronger its conjugate base.
Strength of acid: $CH_3COOH > C_6H_5OH > CH_3CH_2OH$
Strength of conjugate base: $CH_3COO^- < C_6H_5O^- < CH_3CH_2O^-$
lowest pH $\longrightarrow$ highest pH

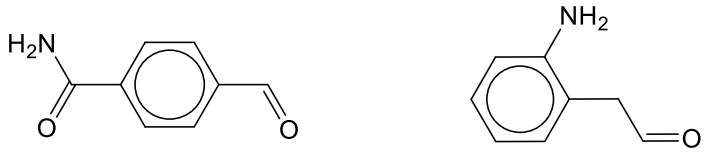
Q28 (Ans: B)



compound E compound F

Option A	Not correct. Three moles of HBr is required (one mole for acid-base reaction with each amine group, one mole for electrophilic addition with alkene group).
Option B	Correct. Two moles of $SOCl_2$ is required (one mole for nucleophilic substitution with each alcohol group).
Option C	Not correct. Three moles of CH_3COCl is required (one mole for condensation with each alcohol group, one mole for condensation with primary amine) (Note: tertiary amines cannot form amides with CH_3COCl.)
Option D	Not correct. One mole of H_2 gas is produced (both alcohol groups will react and the mole ratio of alcohol : H_2 = 1 : ½).

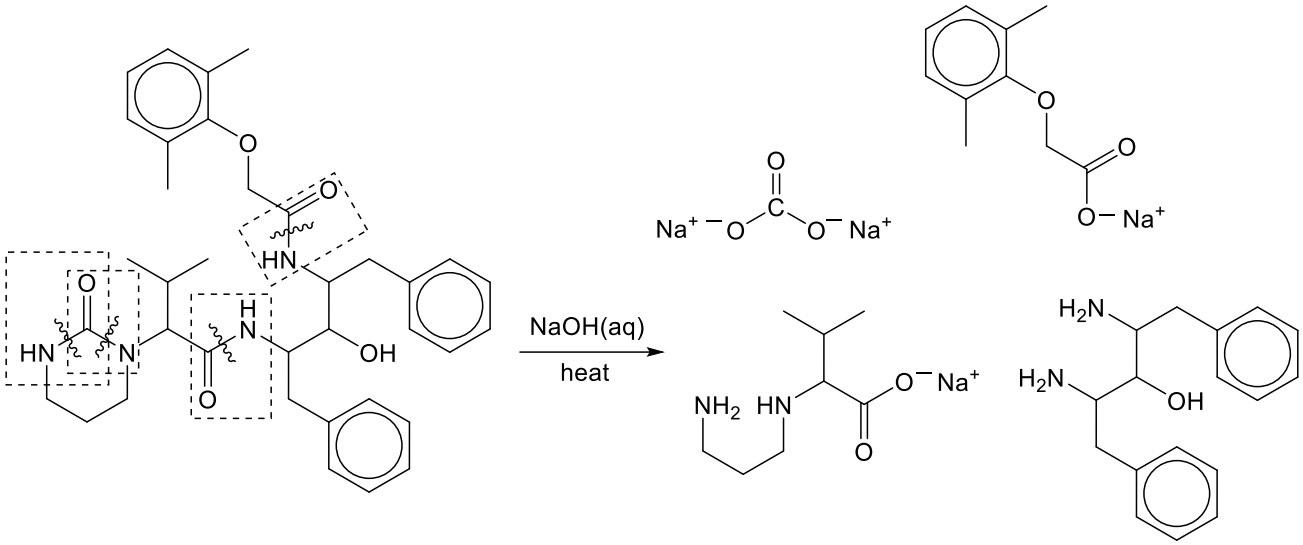
Q29 (Ans: A)



I **II**

	I	**II**
Option A	Contains an aldehyde group and will give silver mirror with Tollens' reagent.	Contains an aldehyde group and will give silver mirror with Tollens' reagent.
Option B	Contains an aromatic aldehyde which will not react with Fehling's solution. Hence no ppt will be formed.	Contains an aliphatic aldehyde and will give a brick-red ppt of Cu_2O with Fehling's solution.
Option C	No reaction with Br_2(aq). Solution remains orange.	Contains a phenylamine group which will undergo electrophilic substitution with Br_2(aq). There will be decolourisation of orange Br_2(aq) and formation of a white ppt.
Option D	Contains a primary amide which will undergo alkaline hydrolysis when heated with NaOH(aq). NH_3 gas evolved will turn damp red litmus paper blue.	No reaction with NaOH(aq). No gas evolved.

Q30 (Ans: D)



Note:

- CO_2 would only be produced if hydrolysis is performed under acidic conditions (i.e. acidic hydrolysis)
- Alcohols do not react with NaOH(aq).