

2016 H2 Chemistry Prelim Exam Paper 2 – Suggested Mark Schemes



[1]

(b)

1. Using a 50.00 cm^3 burette, run **** 50.00 cm^3 of the 5.0 mol dm^{-3} propanone solution into a 250 cm^3 volumetric/standard flask. Make up to the graduated mark with deionised water. Stopper and shake** the flask to obtain a homogeneous solution.

[1] prepⁿ of 1.0 mol dm^{-3} propanone solution

**any appropriate capacity e.g. 100 cm^3 , 150 cm^3*
***calculated volume based on chosen capacity of standard flask*
2. Using a 50 cm^3 measuring cylinder/burette, add 50.0 cm^3 of the diluted propanone solution prepared in step 1 into a 200 cm^3 beaker.
 Using another 50 cm^3 measuring cylinder/burette, add 50.0 cm^3 of 1.0 mol dm^{-3} dilute sulfuric acid into the same beaker. Stir well and label the solution Y.

[1] prepⁿ of solution Y
3. Using a 10 cm^3 measuring cylinder/pipette/burette, add 10.0 cm^3 of solution Y into a boiling tube (labelled Y).
 Using another 10 cm^3 measuring cylinder/pipette/burette, add 10.0 cm^3 of solution X to a second boiling tube (labelled X).

[1] prepare X and Y in separate boiling tubes
4. Place both boiling tubes X and Y in the water bath maintained at 15°C which is prepared by mixing tap water and ice water.
Place a 0.2°C interval thermometer inside tube X and leave both tubes inside the water bath for some time to allow both solutions in the boiling tubes to equilibrate.

[1] place X and Y in water bath set at a particular temp.
5. Then quickly add solution Y from boiling tube Y to boiling tube X, starting the stopwatch simultaneously. Stir well with the thermometer. Record the time taken for the reaction mixture to completely decolourise and the temperature of the reaction mixture.

[1] Mixing and record both t & temp. of mixture
6. Repeat the experiment (steps 3-5) at 4 other different temperatures, 20°C , 25°C , 30°C and 35°C .
 For temperature above room temp., prepare the water bath by mixing tap water and hot water.
 For temperature below room temp., prepare the water bath by mixing tap water and ice water.
 Use a thermometer to monitor the temperature of the water-bath.

[1] state 4 other temps $< 50^\circ\text{C}$ and state how the temp. of both warm & cool water-baths can be achieved

**One of the chosen temp. should be below 25°C .*

(c) As propanone is flammable, do not use direct/naked flame from Bunsen burner for heating. Use hot water to prepare the water bath.

[1]

1 (d) (i) $k \propto \frac{1}{t}$ [1]

(ii) $\ln \left(\frac{1}{t} \right) = \ln A - \left(\frac{E_a}{R} \right) \left(\frac{1}{T} \right)$

By plotting $\ln \left(\frac{1}{t} \right)$ against $\left(\frac{1}{T} \right)$ graph, a straight line graph with gradient of $\left(-\frac{E_a}{R} \right)$ is obtained. [1]

(e) Since the rate is independent of $[I_2]$, [1]
when $[I_2]$ is halved, t is halved. [1]

[Total: 12]

2 (a) (i) $K_{sp} = [Ag^+]^2 [CrO_4^{2-}]$ [1] units: $\text{mol}^3 \text{dm}^{-9}$ [1]

(ii) $1.1 \times 10^{-12} = 4x^3$ [1]
 $x = \underline{6.50 \times 10^{-5} \text{ mol dm}^{-3}}$ [1]

Solubility of Ag_2CrO_4 in g dm^{-3} = $6.50 \times 10^{-5} \times 332 = \underline{0.0216}$ [1]

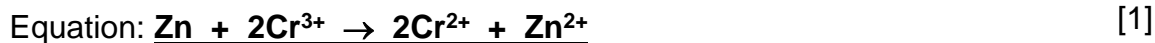
<p>(iii) $[Ag^+]^2 [CrO_4^{2-}]$</p> <p>$= \left(\frac{8.0 \times 10^{-5}}{2} \right)^2 \left(\frac{2.0 \times 10^{-4}}{2} \right)$</p> <p>$= \underline{1.60 \times 10^{-13} < K_{sp} (Ag_2CrO_4)}$ [1]</p>	<p>$[Ba^{2+}] [CrO_4^{2-}]$</p> <p>$= \left(\frac{8.0 \times 10^{-5}}{2} \right) \left(\frac{2.0 \times 10^{-4}}{2} \right)$</p> <p>$= \underline{4.00 \times 10^{-9} > K_{sp} (BaCrO_4)}$ [1]</p>
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\therefore yellow ppt. of $BaCrO_4$ is observed. [1]

(b) Precipitation of $BaCrO_4$ [1] reduces $[CrO_4^{2-}]$ and causes the equilibrium position to shift to the right. [1]

Therefore, $[H^+]$ increases and hence pH of the solution decreases. [1]

(c) $E_{cell} = -0.41 - (-0.76) = +0.35 \text{ V} > 0$



Hence Zn reduces green $Cr^{3+}(\text{aq})$ to blue $Cr^{2+}(\text{aq})$. [1]

$E_{cell} = 0.00 - (-0.41) = +0.41 \text{ V} > 0$ [1]



Hence, on standing, the H^+ present in the solution oxidises blue $Cr^{2+}(\text{aq})$ back to green $Cr^{3+}(\text{aq})$ and H_2 gas is produced.

[Total: 14]

- 3 (a) Due to smaller size of Li^+ , Li^+ has higher charge density.
 Li^+ polarises the large O_2^{2-} anion to a large extent, hence it forms Li_2O instead of Li_2O_2 . [1]

(b) (i) X: P_4O_6 Y: SiO_2 Z: MgO [1]

(ii) SiO_2 has giant molecular structure. Due to the strong covalent bond between Si and O atoms throughout the whole giant structure, it does not hydrolyse in water. [1]

(iii) $\text{P}_4\text{O}_6 + 6\text{H}_2\text{O} \rightarrow 4\text{H}_3\text{PO}_3$ [1]

$\text{MgO} + \text{H}_2\text{O} = \text{Mg}(\text{OH})_2$ Accept " \rightarrow " [1]

(iv) $\text{SiO}_2 + 2\text{OH}^- \rightarrow \text{SiO}_3^{2-} + \text{H}_2\text{O}$ [1]

$\text{P}_4\text{O}_6 + 8\text{OH}^- \rightarrow 4\text{HPO}_3^{2-} + 2\text{H}_2\text{O}$ [1]

(c) (i) $\Delta H_{\text{sol}}(\text{Ca}(\text{OH})_2) = -(-2506) + (-1579) + 2(-460)$
 $= \underline{+7 \text{ kJ mol}^{-1}}$ [1]

(ii)

$$\begin{array}{ccc}
 \text{Ca(s)} + 2\text{H}_2\text{O(l)} & \xrightarrow{\Delta H_r} & \text{Ca(OH)}_2\text{(aq)} + \text{H}_2\text{(g)} \\
 \uparrow 2(-286) & & \uparrow (+7) \\
 \text{Ca(s)} + 2\text{H}_2\text{(g)} + \text{O}_2\text{(g)} & \xrightarrow{(-987)} & \text{Ca(OH)}_2\text{(s)} + \text{H}_2\text{(g)}
 \end{array}$$

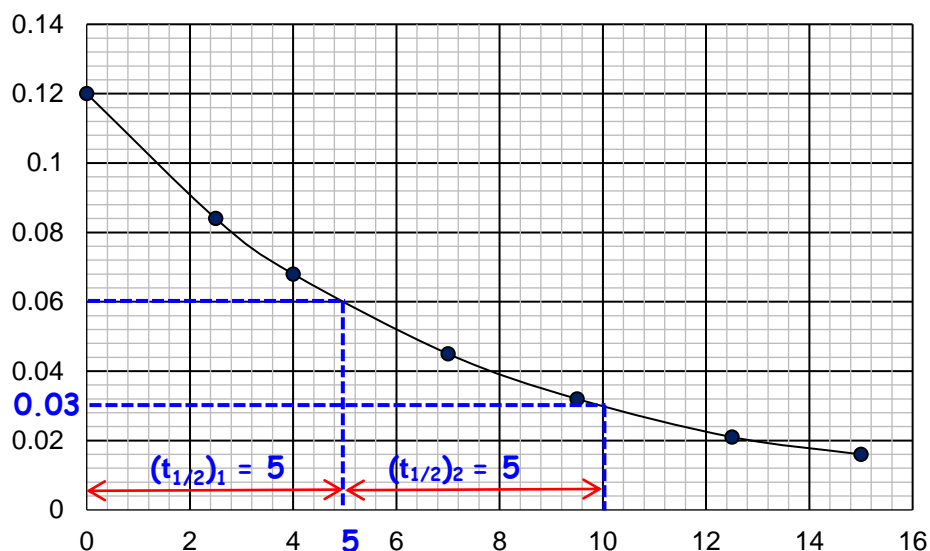
[1]

By Hess' Law,

$\Delta H_r = \underline{-2(-286) + (-987) + (+7) = -408 \text{ kJ mol}^{-1}}$ [1]
 (e.c.f. from ans(c)(i))

[Total: 10]

4 (a)

[NO] / mol dm⁻³

(i) $(t_{1/2})_1 = 5 \text{ min}$, $(t_{1/2})_2 = 5 \text{ min} \Rightarrow t_{1/2} = 5 \text{ min}$ [1]

Since half-lives are constant, the reaction is first order with respect to NO. [1]

(ii) Let rate = $k [\text{NO}][\text{F}_2]^a$ [1]
 Since rate $\propto \frac{1}{t}$,

$$\left(\frac{1.0}{1.5}\right)^a = \frac{\left(\frac{1}{7.5}\right)}{\left(\frac{1}{5}\right)} = \left(\frac{5}{7.5}\right)$$

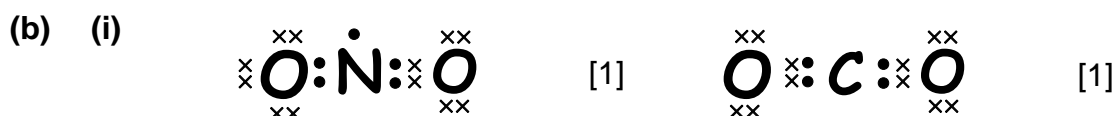
$$\left(\frac{2}{3}\right)^a = \left(\frac{2}{3}\right) \Rightarrow a = 1$$

Hence, order of reaction with respect to F₂ is 1. [1]

(iii) rate = $k [\text{NO}][\text{F}_2]$ [1]

(iv) Step 1: $\text{NO} + \text{F}_2 \rightarrow \text{ONF} + \text{F}\bullet$ slow step [1]

Step 2: $\text{F}\bullet + \text{NO} \rightarrow \text{ONF}$ [1]



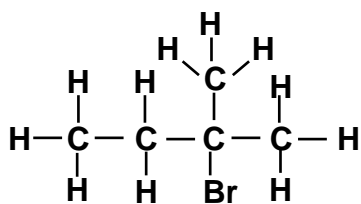
(ii) The permanent dipole-permanent dipole attraction between NO₂ molecules is stronger than the van der Waals' forces between CO₂ molecules. [1]

[Total: 10]

5 (a) (i) Tertiary alcohol

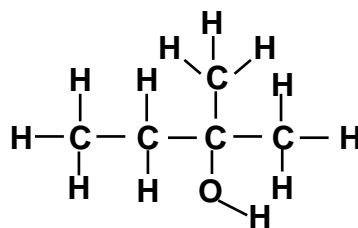
[1]

(ii)



[1]

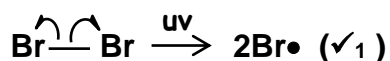
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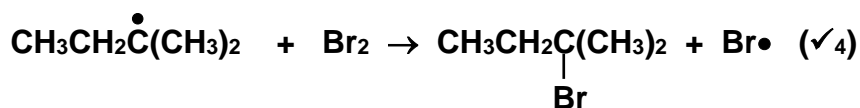
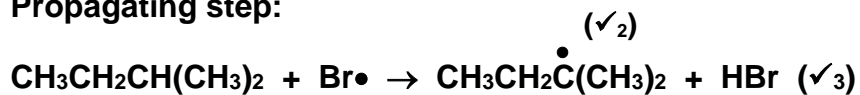
[1]

B

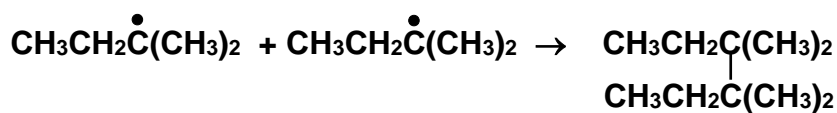
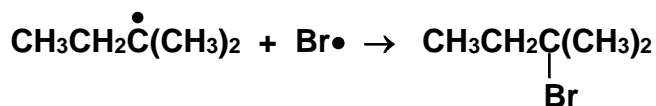
(iii) Initiating:



Propagating step:



Termination ste:

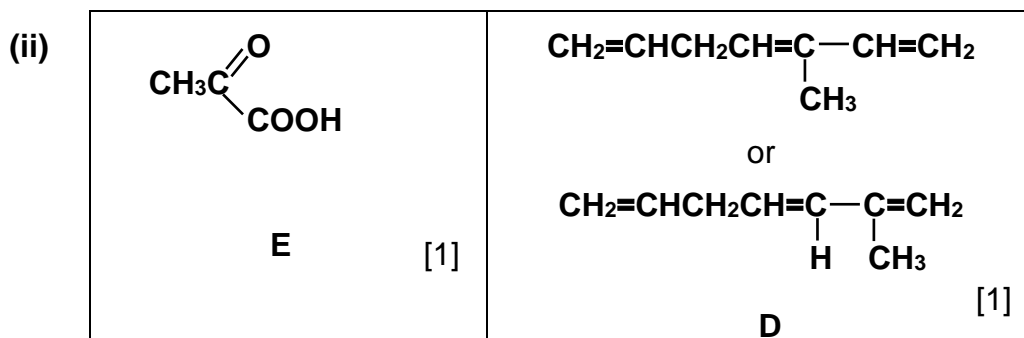


$$\left. \begin{array}{l} (\checkmark_5) \\ (\checkmark_6) \end{array} \right\}$$

6 (✓)	[3]
4-5 (✓)	[2]
2-3 (✓)	[1]

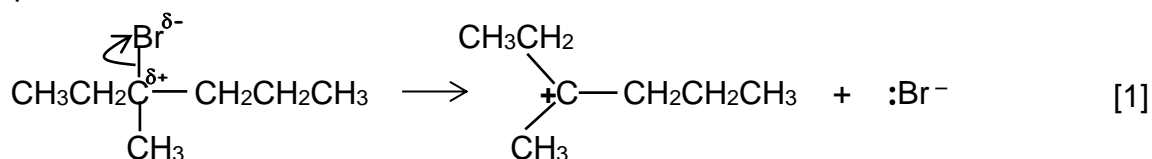
- 5 (b) (i) • alkaline aqueous iodine
 $\text{CH}_3\overset{\text{I}}{\underset{|}{\text{C}}}=\text{O}$ and $\text{CH}_3\overset{\text{I}}{\underset{|}{\text{CH}}}(\text{OH})$ groups [1]

- 2,4-dinitrophenylhydrazine
Ketones and aldehydes [1]

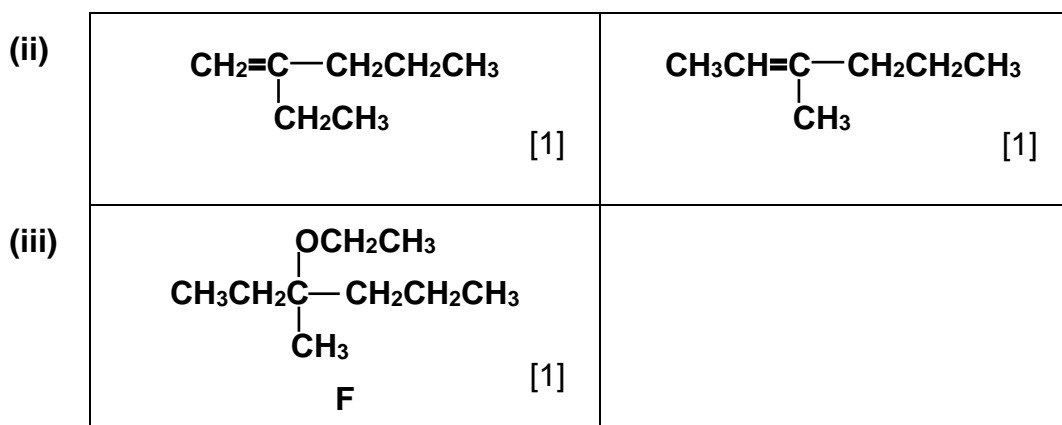
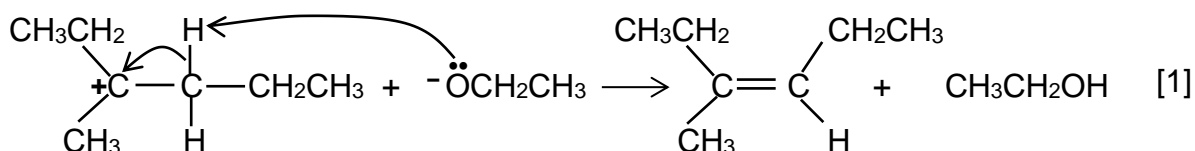


(c) (i)

Step 1:

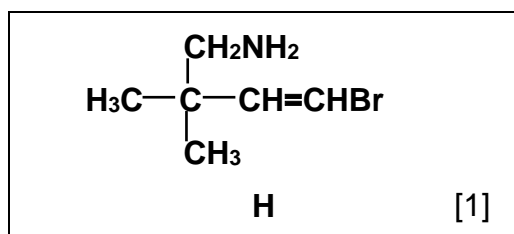


Step 2:



Type of reaction: **Nucleophilic substitution** [1]

5 (c) (iv)



The p orbital of Br atom overlaps with the p orbital of carbon atom of C=C double bond, forming partial double bond character in the C-Br bond, thereby strengthening the C-Br bond. [1]

[Total: 18]

6 (a) (i) POCl₃ and the acyl chloride group in chloroacetyl chloride can undergo hydrolysis if water is present. [1]

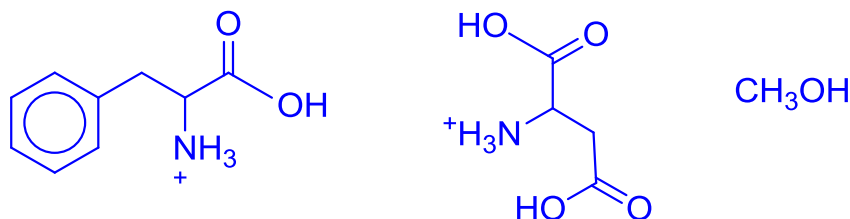
(ii) Excess CH₃NH₂ in ethanol, heat in sealed tube [1]

(iii) Reduction [1]

(b) Two electron-donating alkyl groups bonded to N atom in epinephrine, as compared to only one alkyl group bonded to N atom in cordabrine, make the lone pair on N in epinephrine more available for protonation. [1]

So epinephrine is expected to be the stronger base. [1]

(c)



[1] for each correct hydrolysed product

[Total: 8]