1. Planning (P)

You are to plan an investigation into the thermal decomposition of caesium nitrate, $CsNO_3$.

You may make use of some or all of the following data when planning your investigation.

Data:

Group I element	cation	Ionic radius / nm
lithium	Li^+	0.060
sodium	Na^+	0.095
potassium	K^+	0.133
rubidium	Rb^+	0.148
caesium	Cs^+	0.176

Equation for the thermal decomposition of lithium nitrate and sodium nitrate are given below:

1. $4LiNO_3(s) \rightarrow 2Li_2O(s) + 4NO_2(g) + O_2(g)$
2. $2NaNO_3(s) \rightarrow 2NaNO_2(s) + O_2(g)$

Nitrogen dioxide gas	Oxygen gas
NO_2	O_2
brown in colour	colourless
soluble in water	almost insoluble in water
poisonous	powerful oxidant

1 mol of any gas occupies a volume of approximately 24 dm^3 at room temperature and atmospheric pressure.

A_r: Cs, 133; N, 14.0; O, 16.0

1. Planning (P)

(a) Predict which of the equations below will represent the thermal decomposition of caesium nitrate. Place a tick against the equation of your choice.

$4CsNO_3(s) \rightarrow 2Cs_2O(s) + 4NO_2(g) + O_2(g)$	
$2CsNO_3(s) \rightarrow 2CsNO_2(s) + O_2(g)$	**✓ [1m]**

Use the data provided to explain your prediction.

As the **<u>size/ionic radius of Cs^+ is larger</u>** than that of Na^+, **<u>Cs^+ has a lower charge density and hence has a lower polarising power/less able to polarise the large NO_3^- anion</u>** than Na^+. **[1m]**

(b) You are to plan an experiment in which

- caesium nitrate is heated

- gas is collected
- the volume of gas collected is measured
- the experimental results are used in a calculation to confirm or reject your prediction

(i) Draw a diagram of the apparatus you would use in this experiment.

Your apparatus should use only standard items found in college laboratory. Show clearly how the solid will be heated, the gas collected and its volume measured.
Label each piece of apparatus used, indicating its size or capacity and state the gas or gases collected on your diagram.

[1m] Heat solid $CsNO_3$ in a hard glass tube or boiling tube with a stoppered delivery tube. Must indicate 'Heat' with or without arrow.

[1m] Collect gas over water into an inverted burette or a measuring cylinder; or collect gas directly into a graduated frictionless gas syringe.

[1m] Connect the two apparatus (no gas loss), label the capacity of apparatus for gas volume measurement, state the gas(es) collected in the set-up.

1. **(b)** **(ii)** Calculate the volume of gas you would expect to collect in your apparatus if 1 mol of caesium nitrate completely decomposed according to your predicted equation in **(a)**.

Following equation 2, $2CsNO_3$ º O_2

Expected amount of O_2 = ½ x 1 = 0.5 mol
Expected volume of O_2 gas at r.t.p. = 0.5 x 24 dm^3 = **<u>12 dm^3</u>** **[1m]**

OR *Following equation 1 (for direct collection),* $4CsNO_3$ º $4NO_2$ º O_2

Expected amount of gases (NO_2 and O_2) = 5/4 x 1 = 1.25 mol
Expected volume of O_2 gas at r.t.p. = 1.25 x 24 dm^3 = **<u>30 dm^3</u>**

Following equation 1 (for collection of gas over water), $4CsNO_3$ º O_2

Expected amount of O_2 gas = 1/4 x 1 = 0.25 mol
Expected volume of O_2 gas at r.t.p. = 0.25 x 24 dm^3 = **<u>6 dm^3</u>**

(c) Use your answer to **(b)(ii)** and the size of the apparatus selected in **(b)(i)** to calculate the maximum mass of $CsNO_3$ that can be used in your experiment.

Following equation 2:

Mass of 1 mol of $CsNO_3$ = 195 g

Using 100 cm^3 measuring cylinder or graduated gas syringe,
Maximum volume of gas collected = 100 cm^3
Maximum mass of $CsNO_3$ = 100/12000 x 195 = 1.625 g » **1.63 g (1-2 d.p.)** **[1m]**

OR

Or, Using 50.00 cm^3 burette or graduated gas syringe,
Maximum volume of gas collected = 50 cm^3
Maximum mass of $CsNO_3$ = 50/12000 x 195 = 0.8125 g »**0.81 g (1-2 d.p.)**

Following equation 1 (for direct collection of gas):

Using 100 cm^3 measuring cylinder or graduated gas syringe,
Maximum volume of gas collected = 100 cm^3
Maximum mass of $CsNO_3$ = 100/30000 x 195 = **0.65 g (1-2 d.p.)**

OR

Or, Using 50.00 cm^3 burette or graduated gas syringe,
Maximum volume of gas collected = 50 cm^3
Maximum mass of $CsNO_3$ = 50/30000 x 195 = 0.325 g » **0.33 g (1-2 d.p.)**

Following equation 1 (for collection of gas over water):

Using 100 cm^3 measuring cylinder or graduated gas syringe,
Maximum volume of gas collected = 100 cm^3
Maximum mass of $CsNO_3$ = 100/6000 x 195 = **0.65 g (1-2 d.p.)**

Or, Using 50.00 cm^3 burette or graduated gas syringe,
Maximum volume of gas collected = 50 cm^3
Maximum mass of $CsNO_3$ = 50/6000 x 195 = 1.625 g » **1.63 g (1-2 d.p.)**

1. **(d)** Outline, in a series of numbered steps, the method to be used in the experiment.

Make certain that the steps you describe are in the correct order.
You need not explain how the apparatus is assembled.
Indicate clearly how you will know when decomposed is complete.

1. **Weigh accurately *1.50 g** (should be slightly less than the maximum mass) **of solid $CsNO_3$ into a dry boiling tube** and **record the mass**. **[1m]**
2. Stopper the boiling tube with a delivery tube. **Measure and record the initial volume reading on the gas syringe** (or **in the** inverted **measuring cylinder or burette**). **(ü)** **2(ü)** **[1m]**
3. **Heat the solid** sample gently at first and then **strongly until a constant volume of gas is collected (or there is no movement of piston of the gas syringe or no more gas bubbles is observed in water).** **[1m]**
4. When the whole set-up has been cooled to room temperature, **measure**

and record the final volume reading on the gas syringe (or **in the** inverted **measuring cylinder or burette**). **(ü)**

(e) What should be done when decomposition is complete to ensure that the volume of the gas measured in the apparatus is the “correct” volume.

The **gas or whole set-up needs to be cooled to room temperature before measuring the final volume** (or **repeat the whole experiment with the same mass of solid and take the average readings**) **[1m]**

(f) Identify a risk present in the method you have described and suggest how you would minimise this risk.

O_2 is a powerful oxidant and support burning. **Remove any oxidisable material**. (no mark if student commented that O_2 is flammable.....) **[1m]**

Or,

Only for those who chose equation 1:

NO_2 is poisonous gas. Conduct the experiment inside the fume cupboard.)

Or,

Only for those who collected the gas over water:

Potential suck back may occur and crack the hot tube. Remove the delivery tube from water when heating stops.

[Total: 12]

2. **(a)** **(i)** Write an equation for the reaction between chlorine and cold aqueous sodium hydroxide and state the type of reaction that occurs.

Type of reaction: **Disproportionation** **[1m]**

$Cl_2(g) + 2OH^-(aq) \text{¾¾®} Cl^-(aq) + ClO^-(aq) + H_2O(l)$ **[1m]**

OR $Cl_2(g) + 2NaOH(aq) \text{¾¾®} NaCl(aq) + NaClO(aq) + H_2O(l)$ Ignore s.s

(ii) The resultant solution obtained in **(a)(i)** is heated and a further reaction occurs. Write an equation for the overall reaction between chlorine and sodium hydroxide.

Overall eqn: $3Cl_2(g) + 6OH^-(aq) \text{¾¾®} 5Cl^-(aq) + ClO_3^-(aq) + 3H_2O(l)$ **[1m]**

OR $3Cl_2(g) + 6NaOH(aq) \text{¾¾®} 5NaCl(aq) + NaClO_3(aq) + 3H_2O(l)$

Ignore s.s

(b) Chlorine forms a variety of oxides and oxoanions. A series of standard reduction potentials involving the chlorine oxoanions, in alkaline medium, are shown:

Half-equation	***E*⦵/V**
$ClO^- + H_2O + 2e^- = Cl^- + 2OH^-$	−0.89
$ClO_2^- + H_2O + 2e^- = ClO^- + 2OH^-$	−0.67
$ClO_3^- + H_2O + 2e^- = ClO_2^- + 2OH^-$	−0.33
$ClO_4^- + H_2O + 2e^- = ClO_3^- + 2OH^-$	−0.35

Using the above data and information in the *Data Booklet*, predict the final product formed when excess zinc metal is added to an alkaline solution of chlorate(V), ClO_3^-. Support your answer with $E^\ominus_{cell}$ calculations.

Reaction of zinc metal with chlorate(V):

$$E^\ominus_{cell} = E^\ominus(ClO_3^-/ClO_2^-) - E^\ominus(Zn^{2+}/Zn)$$
$$= -0.33 - (-0.76)$$
$$= \mathbf{+0.43\ V}\ \text{(ü)}$$

Thus, Zn is able to reduce ClO_3^- to ClO_2^-.

Reaction of zinc metal with chlorate(III):

$$E^\ominus_{cell} = E^\ominus(ClO_2^-/ClO^-) - E^\ominus(Zn^{2+}/Zn)$$
$$= -0.67 - (-0.76)$$
$$= \mathbf{+0.09\ V}\ \text{(ü)}$$

Thus, Zn is able to reduce ClO_2^- to ClO^-.

3 (ü) - 2 marks

1-2 (ü) – 1 mark

Reaction of zinc metal with chlorate(I):

$$E^\ominus_{cell} = E^\ominus(ClO^-/Cl^-) - E^\ominus(Zn^{2+}/Zn)$$
$$= -0.89 - (-0.76)$$
$$= \mathbf{-0.13\ V}\ \text{(ü)}$$

[4]

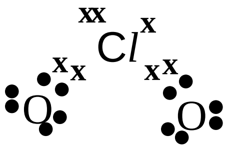
Rxn between ClO^- and Zn^{2+} is not **energetically feasible**

OR **Zn** is **not able to reduce ClO^- to Cl^-**. **[1m]**

Hence, zinc will be oxidised to Zn^{2+} and chlorate(V) will be reduced to **chlorate(I)/ClO^-**. **[1m]** Can infer final product **from conclusion**

2. **(c)** Chlorine dioxide, ClO_2, is a highly reactive gas that is used as a disinfectant to kill water-borne bacteria, viruses and fungi.

Draw a dot-and-cross diagram to show the arrangement of electrons in the ClO_2 molecule. Hence suggest why chlorine dioxide is highly reactive.



[1m]

Chlorine dioxide has **an unpaired electron/odd number of electrons**. Hence it is highly reactive. **[1m]**

[2]

(d) Despite having similar relative molecular mass, the boiling point of chlorine is −34 °C and that of chlorine dioxide is 11 °C.

Give an explanation to account for this large difference in boiling points.

A larger amount of energy is required to break the **stronger permanent dipole-permanent dipole interactions between the ClO_2 molecules** than that to break the ***weaker van der Waals' forces between the Cl_2 molecules***. [2]

[1m] for correct intermolecular forces identified bet. molecules

[1m] for pd-pd stronger than vdw (must compare bet. Correct I.M.F)

[Total: 11]

3. **(a)** Aluminium is obtained by electrolysis of molten Al_2O_3 using inert electrodes.

(i) Give ion-electron equations, with state symbols, for the electrode processes:

at the cathode: $\mathbf{Al^{3+}(l) + 3e^- \rightarrow Al(l)}$ **[1m]**

at the anode: $\mathbf{O^{2-}(l) \rightarrow ½O_2(g) + 2e^-}$ **[1m]**

s.s. required, reject "="

for wrong or missing s.s. AND half-eqns are correct: 1m only

(ii) Calculate the mass of aluminium produced when a current of 8 A is passed for 100 minutes through the molten Al_2O_3.

Amount of e^- transferred = 48000/96500 = **<u>0.497</u>** mol (ignore sf) **[1m]**

Mass of Al produced = 0.497/**3** x 27.0 = **<u>4.47 g</u>** **[2m]**

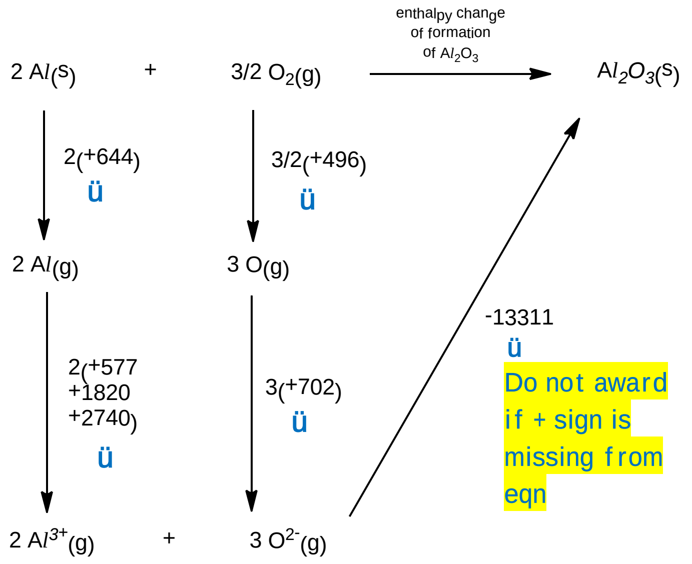
(1st mark ecf from (a)(i) for mole ratio)

(1 – 3 sf for final answer (2nd mark) + correct units) [5]

(b) The enthalpy change of formation of Al_2O_3 can be calculated from a Born-Haber cycle.

Construct the Born-Haber cycle for the formation of Al_2O_3, using the following data and relevant data from the *Data Booklet*. Hence, calculate the enthalpy change of formation of Al_2O_3.

	Δ*H* / kJ mol^{-1}
Enthalpy change of atomisation of aluminium	+644
Sum of 1st and 2nd electron affinities of oxygen	+702
Lattice energy of Al_2O_3	–13311



Do not award if + sign is missing from eqn

[1m] for balanced $Al_2O_3(s)$ **formation equation**

5✓: [3m]
4✓: [2m]
2-3✓: [1m]
0-1✓: [0m]

Do not double penalise:
Award 1✓ for L.E if student miss out state symbols for Al_2O_3 (first 1m is already penalised)

$\Delta H_f(Al_2O_3(s))$ = 2(644) + 2(5137) + (3/2(496)) + 3(702) – 13311 = **<u>+1101</u>** kJ mol^{-1}

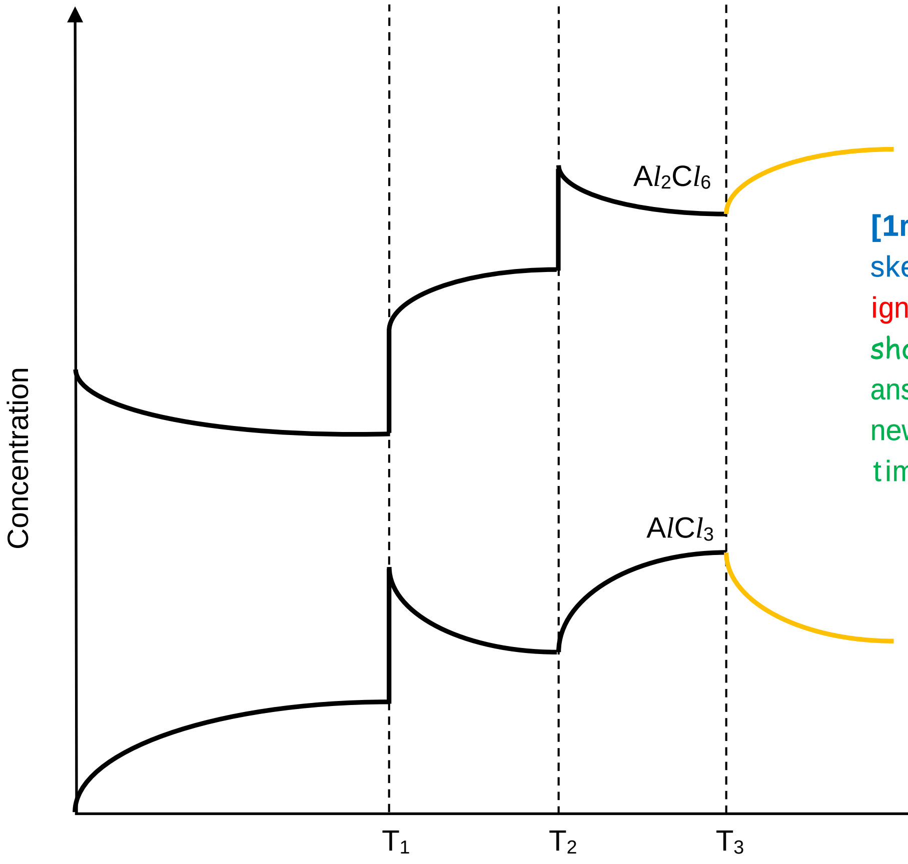
[1m] for final answer (exact/3 sf), no ecf

Award each (✓) only if
- equation is balanced
- state symbol of reactants and products are stated correctly
- process is labelled with correct Δ*H* value or symbol (ignore "+" sign)
- Δ*H*$_f$ can be accepted (infer to question)

3. **(c)** Aluminium chloride exists in two different forms in the vapour state and the following conversion exists between them:

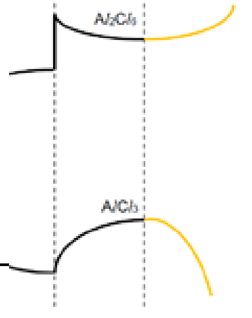
$$Al_2Cl_6(g) \quad \rightleftharpoons \quad 2AlCl_3(g)$$

The conversion was studied using a fixed amount of Al_2Cl_6 in a reaction vessel. At different times during the experiment, changes were made to the conditions in the reaction vessel. The change in the concentrations in the equilibrium mixture with time is given by the graph below.



[1m] for correct sketch (with ecf), ignore magnitude, show in students' answers reaching new eqm at the same time

Do not accept:



(i) Suggest the changes that caused the equilibrium shifts at time:

T_1: **decrease in** total **volume** of reaction vessel/**increase in pressure** **[1m]**

T_2: **addition of/increase in concentration/**(partial) **pressure of Al_2Cl_6** (OWTTE) **[1m]**

Reject "decrease in volume of (specific gas)", accept "decrease in volume of gases"........ Same for suggestions in pressure

Accept wrongly-written formula of Al_2Cl_6 (Benefit Of Doubt), and reject "$AlCl_3$"

(ii) Explain whether the conversion of Al_2Cl_6 to $AlCl_3$ is expected to be exothermic or endothermic.

It is expected to be **endothermic.** **[1m]**

This is because there is **breaking of** (dative covalent) **bonding** between the Cl and Al atoms. **[1m]**

Accept:

"break molecule/ dimer"

3. **(c)** **(iii)** Sketch on the same axes of the given graph on page 9, the changes in the concentration of Al_2Cl_6 and $AlCl_3$ when the mixture was cooled at time T_3. Explain your answer with reference to your conclusion made in **(c)(ii)**.

When temperature is lowered, the **equilibrium** position will **shift** to the **left, favouring** the **exothermic reaction**, so as to increase temperature. **[1m]**

OR

When temperature is lowered, it **favours** the **backward exothermic reaction**, so as to increase temperature.

Hence, yield of Al_2Cl_6 increases and yield of $AlCl_3$ decreases.

Ecf from c(ii)

(iv) At a total pressure of 1 atm and 673 K, Al_2Cl_6 was 30% dissociated into $AlCl_3$.

Calculate the equilibrium constant, K_p, including its units, at 673 K.

Let p be the initial partial pressure of Al_2Cl_6 (g).

	Al_2Cl_6(g)	=	$2AlCl_3$(g)
Initial partial pressure/ atm	P		-
Eqm partial pressure/ atm	$\mathbf{0.7p}$		$\mathbf{0.6p}$

$0.7p + 0.6p = 1$ atm

$\mathbf{p} = 0.769$ atm

At eqm, P_{Al2Cl6} = 0.7 ´ 0.769 = **0.538 atm**

P_{AlCl3} = 0.6 ´ 0.769 = **0.462 atm (0.461 atm)**

~~[1m] ignore sf~~

[1m] ignore sf

[9]

$$K_p = \frac{0.462^2}{0.538}$$ **[1m]**

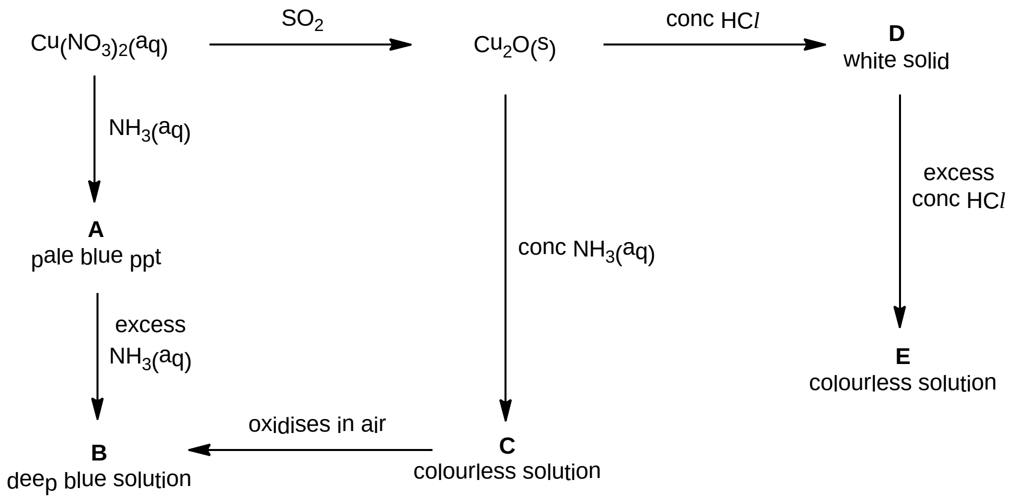
for correct substitution (ecf from p.p.) in correct K_p expression

= **0.397 atm (0.395 atm or 0.396 atm)**

[1m] correct answers + units + 3 sf (ecf only for correct K_p expression)

4. **(a)** Copper is a transition element that forms a rich variety of compounds with varying oxidation states.

Aqueous copper(II) nitrate, $Cu(NO_3)_2$ is a blue solution which can undergo the following reactions.



B, **C** and **E** contain complex ions of copper. Both compound **D** and complex ion **E** contain copper and chlorine only.

(i) What are the formulae of the compound **A** and of the cation present in **B**?

A: $Cu(OH)_2$ **B**: $[Cu(NH_3)_4(H_2O)_2]^{2+}$ **[2m]**

(ii) Suggest a balanced equation for the formation of **B** from **A**.

$Cu(OH)_2(s) + 4NH_3(aq) + 2H_2O(l)$ ® $[Cu(NH_3)_4(H_2O)_2]^{2+} + 2OH^-(aq)$ **[1m]**

s.s not required

(iii) State the role of SO_2 in the conversion of $Cu(NO_3)_2$ to Cu_2O.

Reducing agent/Reductant (mark for meaning) **[1m]**

(iv) The composition of complex ion **C** by mass is Cu, 65.1%, N, 28.7%, H, 6.2%.

Use the data to determine the empirical formula and identity of complex ion **C**.

Cu	N	H
65.1	28.7	6.2
63.5	14.0	1.0
1.025	2.05	6.2
1	**2**	**6**

[1m]

Working for empirical formula must be shown

Empirical Formula = CuN_2H_6 or **$Cu(NH_3)_2$ (ignore charge if its given)**

Identity: $Cu(NH_3)_2^+$ **[1m]**

(v) The oxidation number of copper in compound **D** and complex ion **E** are the same as that in compound **C**, and both **D** and **E** contain copper and chlorine only.

Suggest the formulae of **D** and **E**.

D: **CuCl** **E**: **$CuCl_2^-$** **[2m]**

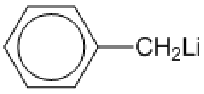
[8]

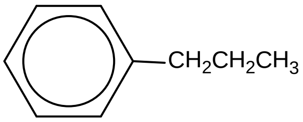
4. (b) Copper forms a very useful group of organic compounds known as Gilman reagents.

$$\underset{\textit{methyllithium}}{2CH_3Li} + CuI \xrightarrow{\text{in ether}} \underset{\textit{Gilman reagent}}{(CH_3)_2CuLi} + LiI$$

Alkyl halides (except fluorides) undergo nucleophilic substitution with Gilman reagents.

$$\underset{\textit{ethyl chloride}}{CH_3CH_2Cl} \xrightarrow{(CH_3)_2CuLi} CH_3CH_2CH_3 + CH_3Cu + LiCl$$

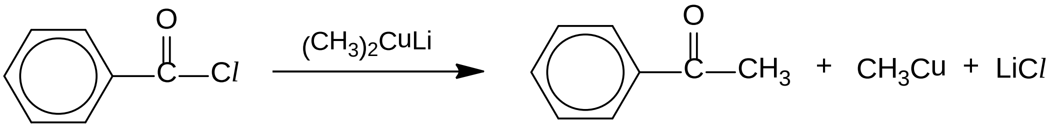
(i) Suggest the structural formula of the final organic product formed when phenyllithium,  , and bromoethane are used in a similar two-step process.



[1m]

accept "$C_6H_5CH_2CH_2CH_3$", reject "$-C_3H_7$".

(ii) Gilman reagents can also react with acyl chlorides to form ketones. An example is shown below:



It is observed that the reaction with acyl chlorides takes place much more readily than that with alkyl chlorides. Explain why this is so.

It is because the carbonyl **C atom/C** in >C=O **of acyl chlorides** (the electron-deficient C atom must be clearly specified in the answer) is **more/highly electron deficient**, due to it being **bonded to** 2 **electronegative/ electron-withdrawing** atoms, **O and Cl**. Hence it is more susceptible to nucleophilic attacks. **[1m]** **[1m]**

[3]

Or **bonded to one more electronegative O atom**

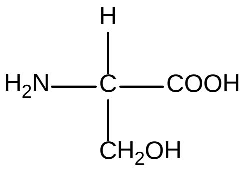
OR the trigonal planar **sp^2 hybridised C in –COCl experience less steric hindrance** than the tetrahedral sp^3 hybridised C in alkyl chloride.

[1m] correct sp^2 and sp^2 assignment (or no. of alkyl groups)

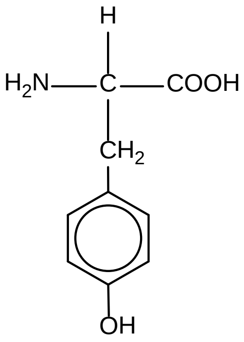
[1m] steric hindrance comparison

[Total: 11]

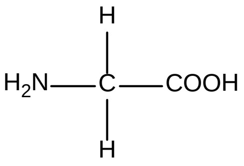
5. **(a)** The Green Fluorescent Protein (GFP) is a protein that can be isolated from the jellyfish, *Aequorea victoria*, and it can exhibit bright green fluorescence when exposed to ultraviolet light. The chromophore is the section of the GFP that fluoresces and contains the amino acid sequence *ser-tyr-gly*.



ser

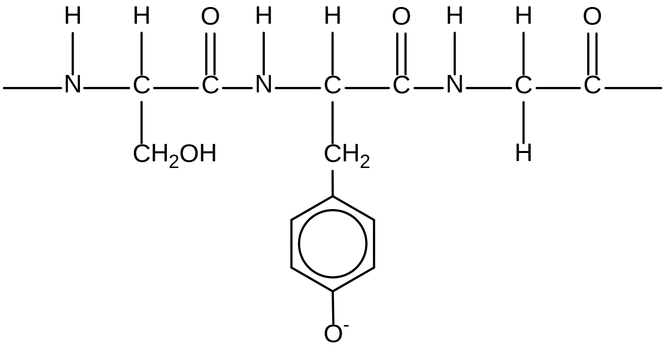


tyr



gly

(i) Draw the structure of this section of the GFP at pH 14.



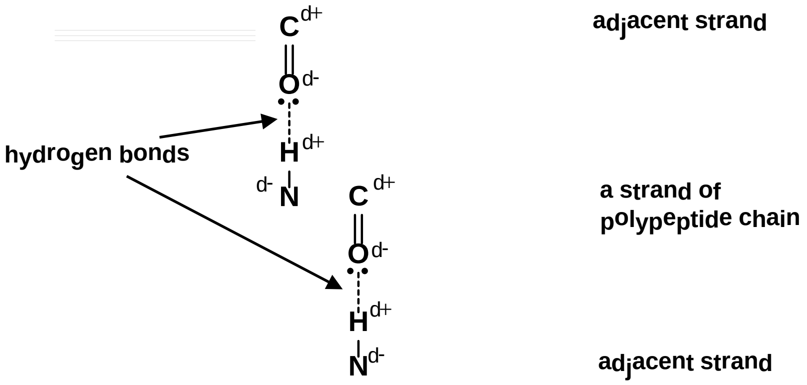
[1m] for correct amino acid sequence and fragment of protein drawing

[1m] for acid-base reaction with phenol, forming phenoxide

(ecf 2nd mark: if tripeptide is drawn and must accompany by acid-base reaction with any acidic groups: both phenol and COOH)

(ii) GFP has a beta barrel structure, consisting of one *b-pleated sheet* and a-helices running through the centre of the barrel structure.

Sketch a labelled diagram to show how two groups in a protein could be involved in maintaining the structure of the *b-pleated sheet*.



[1m] correct structure of *b*-pleated sheet, showing C=O and N- H groups involved in forming the stabilising forces, N and C must be on the polypeptide backbone, strands of polypeptide chain must be labelled.

[1m] at least 1 hydrogen bond correctly drawn ***Reject*** *"H-bond".*

Accept anti-parallel/parallel diagrams and accept zigzag displayed [4]

Accept "polypeptide strand" in place of "a strand of polypeptide chain"

5. **(b)** A venomous jellyfish has tentacles containing 'stinging cells' that inject venom into the skin of a victim. The venom is made up of a diverse variety of proteins and polypeptides capable of inflicting pain and swelling.

The most common first-aid treatment of jellyfish stings is to get the victim out of water, scrape off any attached tentacles with a hard object and rinse the affected area with hot seawater to deactivate the venom.

Explain how the application of heat is effective in treating jellyfish stings.

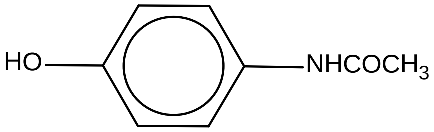
Heat will disrupt the weak interactions: **van der Waals' forces in the tertiary and quaternary structures and hydrogen bonds in the secondary, tertiary and quaternary structures** of the proteins in the venom (and the nematocysts).

This **alters the conformation/(3D) shape of the proteins** which causes the **polypeptide chain folds differently**/ **this denatures the protein**

[1m] : at least one correct R group interaction + structure disrupted

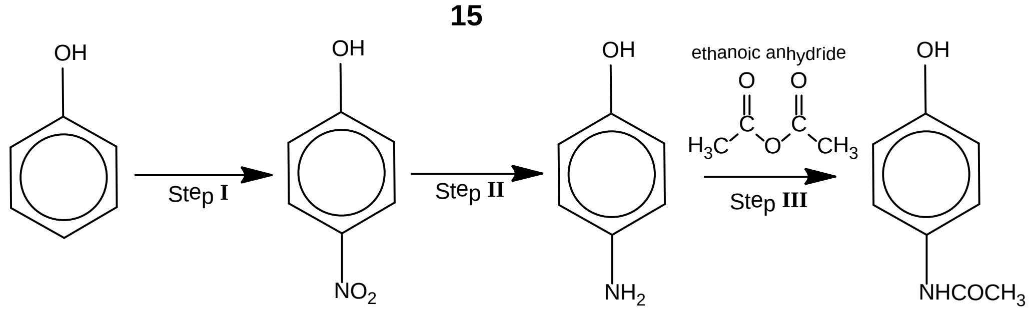
[2m] : for everything stated above(*without any other extra R group interaction)

(c) Paracetamol is usually prescribed to the casualty to reduce the pain from the jellyfish sting.



Paracetamol

A student suggested that paracetamol can be synthesised from phenol, via a three-step reaction sequence as proposed below.



4-aminophenol paracetamol

(i) What types of reaction take place in Step **I**, **II** and **III**?

Step **I**: **Electrophilic Substitution** **[1m]**

Step **II**: **Reduction** **[1m]**

Step **III**:

Nucleophilic Substitution/Amide formation/Condensation **[1m]**

No spelling mistake allowed

5. **(c)** **(ii)** State the reagents and conditions needed for Step **I** and **II**.

Step **I**: **Dilute HNO_3** (aq) **[1m]** reject "aqueous HNO_3", "heat"

Step **II**: **Concentrated HC*l***(aq)**, Sn, heat [1m],**

followed by controlled amount of NaOH(aq) **[1m]**

Reject "HCl(aq)"

(iii) In actual practice, 4-aminophenol is used instead as the starting material and only Step **III** is carried out.

Given that both phenol and 4-aminophenol are easily available, suggest a reason why phenol is not chosen to be the starting material to prepare paracetamol in actual practice.

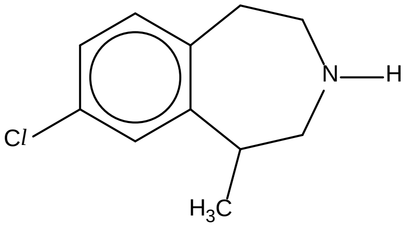
This is because **2 isomers will be produced (2-aminophenol & 4-aminophenol)/mixture of isomers will be formed** **[1m]**

and separation of isomers/separation of 4-aminophenol from 2-aminophenol is not easy/extra step for separation to carry out. [7]

Thus, resulting in poor yield of product.

[Total: 13]

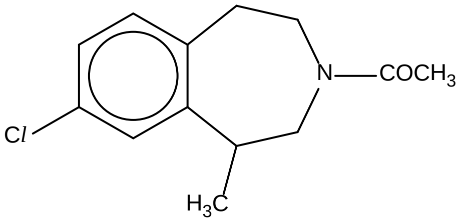
6. Lorcaserin (Trade name: Belviq®) is a weight-loss drug developed by Arena Pharmaceuticals in San Diego and is recently approved by the US Food and Drug Administration in June 2012 for use in the treatment of obesity for adults.



Lorcaserin

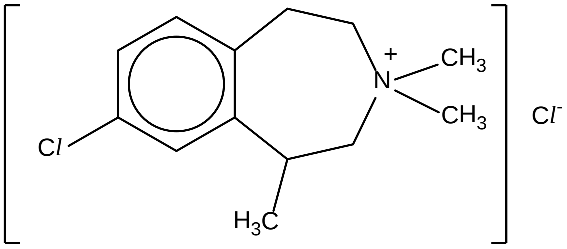
(a) Draw the structures of the organic compounds formed when Lorcaserin is treated with the following reagents.

(i) ethanoyl chloride



[1m] correct product

(ii) excess CH_3Cl



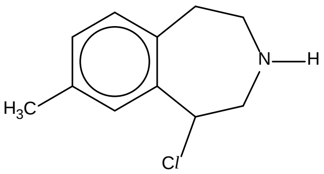
[2]

[1m] correct cation (if cation is given only)

[bonus 1m] correct product (with Cl^-)

No double penalty for consistent structure mistake made in (a)(i) & (a)(ii)

6. **(b)** An isomer of lorcaserin (Compound **Y**) is shown below.



Compound **Y**

Suggest a chemical test (stating reagents and observations) that would distinguish Compound **Y** from lorcaserin.

Test: 1. **Add aqueous NaOH/KOH** to each compound separately and **heat**.

2. Add (aqueous) dilute **HNO_3** to **acidify** the resulting mixtures

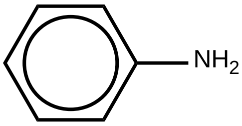
OR Add (aqueous) dilute **HNO_3** to the resulting mixtures **to remove excess NaOH**.

OR Add **EXCESS** (aqueous) dilute **HNO_3** to the resulting mixtures

3. Then, add (aqueous) **$AgNO_3$** to the resulting mixtures. **[1m]**

White precipitate / ppt. of Ag*Cl* is **formed with Compound Y**, but **not with lorcaserin**. **[1m] mark observations only when reagents (aq. NaOH and aq. $AgNO_3$) are correct** [2]

(c)



phenylamine

Suggest and explain how the basicity of lorcaserin might compare with that of phenylamine.

Phenylamine will be **less basic/a weaker base** than lorcaserin. **[1m]**

The p-p orbital overlap in phenylamine results in **delocalisation of the lone pair** of electrons **on N atom into the benzene ring**, **making the lone pair less available for protonation**, hence phenylamine is a weaker base. **[1m]** [2]

Reject ".. making N less available..."

[Total: 6]