INSTRUCTIONS

1. Write your STUDENT ENROLMENT NUMBER (SEN) on the top right hand corner of this booklet.
2. Answer ALL QUESTIONS. Write your answers in the spaces provided in this booklet.
3. If you need more space for answers, ask the Supervisor for extra paper. Write your SEN on all extra sheets used and clearly number the questions. Attach the extra sheets at the appropriate places in this booklet.

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<td>75</td>
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Check that this booklet contains pages 2-19 in the correct order. Page 16-,18,19 has been deliberately left blank.
Show all working. Unless otherwise stated, numerical answers correct to three significant figure. Periodic table has been provided at the end of the booklet. (page 17)

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.
SECTION A    MULTIPLE CHOICE QUESTIONS

Write the LETTER of your choice on the appropriate box at the side of each question.

Question 1:
Nuclear fission is the process where____________________.
A. small parts come together to form a large mass
B. a large nucleus breaks up into two smaller nuclei
C. multiple atoms combine to form a large atom
D. a huge nuclear breaks up giving off a lot of ice

Question 2:
The enthalpy change that occurs in a system when one mole of matter is transformed by a chemical reaction under standard condition is called:
A. Standard enthalpy of reaction.
B. Standard enthalpy of combustion.
C. Standard enthalpy of fusion.
D. Enthalpy of vapourisation.

Question 3:
Which ONE (1) of the following equations is a redox reaction?
A. NaOH + HCl → H₂O + NaCl
B. KCl + AgNO₃ → AgCl + KNO₃
C. Mg + AlCl₃ → MgCl₃ + Al
D. 2C₂H₆ + 7O₂ → 4CO₂ + 6H₂O

Question 4:
Which of the following is the product of the following reaction?

\[ \text{LiAlH}_4 + \text{CH}_3 - \overset{\text{O}}{\text{C}} - \text{H} \rightarrow \]
A. CH₃COOH
B. CH₃CO
C. CH₃COH
D. CH₂COOH
Section B: Short Answer Questions

Answer All Questions Of This Section On The Spaces Provided.

Question 1: Atomic Structure, Bonding & Related properties.

a. Draw the Lewis Structure of Carbon Dioxide.

b. Write the ground state electron configuration of Chromium using the s, p, d and f notation.

c. Differentiate between the fission and the fusion reactions.
d. Find the pH during the titration of 20ml of 0.10M butanoic acid, CH₃CH₂CH₂COOH (Ka =1.54 x 10⁻⁵) with 0.10 M NaOH solution and the appropriate indicator after the following additions of titrants: 0 mL and 25mL.
Question 2: Equilibrium and the Energetics of Physical and Chemical Processes

a. Calculate the $\Delta H^\circ$ for the reaction:

$$2\text{H}_2\text{S}(g) + 3\text{O}_2(g) \rightarrow \text{SO}_2(g) + \text{H}_2\text{O}(g)$$

Given:

**Standard Enthalpies of Formation at 25°C**

<table>
<thead>
<tr>
<th>Formula</th>
<th>$\Delta H^\circ (kJ/mole)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>H$_2$O (g)</td>
<td>-241.8</td>
</tr>
<tr>
<td>O$_2$ (g)</td>
<td>0</td>
</tr>
<tr>
<td>SO$_2$ (g)</td>
<td>-297</td>
</tr>
<tr>
<td>H$_2$S (g)</td>
<td>-21</td>
</tr>
</tbody>
</table>

b. Use the given bond energies to calculate the enthalpy of reaction, of Ethene and Chlorine

**Average Bond Energies:**

<table>
<thead>
<tr>
<th>Bond</th>
<th>Bond Energy (KJ/mol)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C – H</td>
<td>413</td>
</tr>
<tr>
<td>C – Cl</td>
<td>339</td>
</tr>
<tr>
<td>Cl – Cl</td>
<td>243</td>
</tr>
<tr>
<td>C = C</td>
<td>614</td>
</tr>
<tr>
<td>C – C</td>
<td>347</td>
</tr>
</tbody>
</table>

Skill level 2

| 2 | 1 | 0 | NR |
c. Differentiate between the endothermic and exothermic reactions in relation to the bond making and bond breaking processes and give the appropriate examples of these.

<table>
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<td>3</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>0</td>
</tr>
<tr>
<td>NR</td>
</tr>
</tbody>
</table>

d. Determine which of the following electrolytes is stronger and support your answer with the relevant equation and calculations.

0.1 M of CH₃COOH and 0.1M of HCl.

\[ Ka = 1.8 \times 10^{-5} \quad \text{Ka} = 1.3 \times 10^6 \]
Question 3: Redox Reactions and Organic Chemistry

a. An electrochemical cell is set up based on the reaction nickel metal and hydrogen peroxide.

\[ E^\circ(H_2O_2/H_2O) = +1.77 \, V \]
\[ E^\circ(Ni^{2+}/Ni) = -0.62 \, V \]

i. This reaction is to be used in an electrochemical cell.

Complete the standard cell diagram below for the cell.

ii. Explain how the electrochemical cell in i. can be used in everyday life, giving its applications and limitations.

b. Draw and name TWO (2) structural formulae of the isomers of Butene.
c. Describe the structure of polyethylene and identify its properties in relation to its structure.
Question 4: Equilibrium & Organic Chemistry

a. An unknown colourless organic solution is soluble in water and tested neutral with pH paper. The same liquid tested positive with the Lucas reagent. Identify the Unknown solution and explain how it may test positive with the Lucas reagent by the use of an equation.

b. Calculate the molar solubility of FeCO$_3$ (Ksp = 3.07 $\times$ 10$^{-11}$).
c. Compare the solubility of AgCl in pure water, $K_{sp} = 1.8 \times 10^{-10}$ at 25° C and when $\text{NH}_3(\text{g})$ is added to the solution. Then account for the difference. $K_f$ of $\text{Ag}(\text{NH}_3)_2^+ = 1.6 \times 10^6$. 
Question 5: Equilibrium and Organic Chemistry

a. Describe the reaction of ethanol with concentrated sulfuric acid using a balanced equation.

b. Write the chemical reaction to describe the reaction of ethanoyl Chloride and propanol.

c. Describe the hydrolysis reaction of ethyl butanoate include all conditions the reaction takes place in.

d. Discuss and analyse THREE (3) factors which can affect the equilibrium position of a reaction using specific examples.
Question 6: Equilibrium and Organic Chemistry

a. Describe the buffer solution including when weak acid or base is added to it using the relevant equations.

b. Use the IUPAC rules to name the following amine isomers.

\[
\begin{array}{ccc}
\text{NH}_2 & \text{CH}_3 & \text{NH}_2 \\
| & | & \\
\text{CH}_3 - \text{CH}_2 - \text{CH} - \text{CH}_3 & \text{and} & \text{CH}_3 - \text{CH} - \text{CH}_2 - \text{CH}_2
\end{array}
\]

c. Explain how the structure of an organic compound determines the reactions it is involved in, use an ester as an example.
d. Explain how water management practices (supply, irrigation and runoff) are used to maintain sustainable production.
**Question 7**  
**Equilibrium and Energetics of Physical and Chemical Processes.**

a. Define Enthalpy change.

b. Find the $\Delta H$ in Kilo Joules for:

\[
\text{Ca(s) + } \frac{1}{2} \text{O}_2 (g) + \text{CO}_2 (g) \rightarrow \text{CaCO}_3 (s)
\]

Given the following reactions:

\[
\text{Ca(s) + } \frac{1}{2} \text{O}_2 (g) \rightarrow \text{CaO (s)} \quad \Delta H = -635 \text{ KJ}
\]

\[
\text{CaCO}_3 (s) \rightarrow \text{CaO (s) + CO}_2 (g) \quad \Delta H = 178 \text{ KJ}
\]

c. Propanoic acid (CH$_3$CH$_2$COOH, which we will simplify as HPr) is a carboxylic acid whose salts are used to retard mold growth in foods. Calculate the [H$_2$O$^+$] of 0.10 M HPr ($K_a = 1.3 \times 10^{-5}$).
d. Draw the structural formula of the substance that will be formed in the reaction between $K_2Cr_2O_7$ and $CH_3CO H_2CH_3$ in an acidic medium.

e. The boiling points of ammonia $NH_3$, fluorine $F_2$, and hydrogen chloride HCl, are given in the table below.

<table>
<thead>
<tr>
<th>Molecule</th>
<th>Boiling point / °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonia, $NH_3$</td>
<td>-33</td>
</tr>
<tr>
<td>Fluorine, $F_2$</td>
<td>-188</td>
</tr>
<tr>
<td>Hydrogen Chloride HCl</td>
<td>-85</td>
</tr>
</tbody>
</table>

Discuss the differences between the boiling points of $NH_3$, $F_2$ and HCl, in terms of the strength of the attractive forces between the particles involved.
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