<table>
<thead>
<tr>
<th>MARK SCHEME</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAXIMUM MARK : 40</td>
</tr>
<tr>
<td>SYLLABUS/COMPONENT : 9701 /6</td>
</tr>
<tr>
<td>CHEMISTRY (OPTIONS (A2))</td>
</tr>
</tbody>
</table>
Biochemistry

1. (a) (i) [Chemical structures with molecular bonds and labels]

(ii) Chiral / anomic / optically active centre is created since rotation is possible at C₁

(b) Hydrogen bonding

\[ \text{C - O - H} \quad | \quad | \quad | \quad | \quad | \quad | \quad | \quad \text{O} \quad | \quad | \quad \text{H} \]

(c) (i) glucose + ATP \( \rightarrow \) glucose-6-phosphate + ADP

an enzyme / hexokinase / glucokinase is needed

(ii) [Chemical structure of glucose-6-phosphate]

(iii) Glucose-6-phosphate is a competitive/reversible inhibitor

It fits into the active site on the enzyme/similar shape to glucose
2. (a) (i) 

Axles labelled 
Graph 
$V_{\text{max}}$ and $V_{\text{max}}/2$ indicated 

(ii) Check lines on sketch above for $V_{\text{max}}/2$ to give $K_m$ as $[S]$ 

(iii) The value of $K_m$ shows the efficiency / effectiveness of the enzyme / affinity of the enzyme for the substrate / strength of the enzyme-substrate bond 

Small values for $K_m$ indicate very efficient systems 

(b) (i) Correct line on sketch 
Competes for active sites on the enzyme 

(ii) Correct line on sketch 
Increase the efficiency of the enzyme
Environmental Chemistry

3. (a) Increased use of fertilisers
   Leaching / runoff of soluble compounds such as nitrates
   This increases the growth of algae
   When these die and decay they use up dissolved oxygen / eutrophication (1) [4]

(b) Water from the Baltic is less dense due to lower salinity and higher temperatures (both required) (1)

(c) Nutrient levels are greatest in the North Sea water in which the algae grow
   The 'jump' layer is not as mobile as the surface waters / little or no mixing (1) [2]

(d) The algal decomposition mainly affects the deeper waters reducing the oxygen content
   Oxygen loss is less significant at the surface
   The smaller the cod populations, the fewer herrings are eaten
   Cod are found at greater depths where the oxygen loss is greatest (1) [max 2]

(e) This shows severely reducing conditions / a large oxygen loss. (1)
4. (a) Lack of flammability / inertness to combustion

Suitable volatility / easily liquefied

Lack of reactivity towards other chemicals present

Non-toxic

(b) \[ \text{CFCl}_3 \rightarrow \text{CFCl}_2^\cdot + \text{Cl}^\cdot \quad (1) \]

\[ \text{Cl}^\cdot + \text{O}_3 \rightarrow \text{ClO}^\cdot + \text{O}_2 \quad (1) \]

\[ \text{ClO}^\cdot + \text{O} \rightarrow \text{Cl}^\cdot + \text{O}_2 \quad (1) \]

Cl\textsuperscript{•} is recycled, and can thus destroy many ozone molecules

(c) (i) It breaks down more easily \( (1) \)

(ii) CFC-11 must have a shorter residence time than CFC-12 \( (1) \)

CFC-12 must have a very long residence time (> 100 years) \( (1) \) \[ max 2 \]

(d) HCFCs are more readily destroyed in the troposphere \( (1) \)

The C—H bond is more readily attacked, and this promotes the breakdown of the molecule \( (1) \)

Polarisation of the C-H bond \( (1) \) \[ max 2 \]
Phase Equilibria

5.  (a) As the molecules gain energy
    the forces between them become much weaker
    The magnitude of the change is proportional to $\Delta H_{\text{vap}}$ [max 2]

(b) (i) $\text{H}_2\text{O}$ has a high b.p. due to hydrogen bonding

Diagram of water showing 2 H-bonds per molecule

$\text{H}_2\text{S}$ to $\text{H}_2\text{Te}$ have similar intermolecular dipole-dipole forces / van der Waals'

(ii) $\text{H}_2\text{O}$ : $\frac{40.7}{373} = 0.109$  $\text{H}_2\text{S}$ : $\frac{18.7}{213} = 0.088$

$\text{H}_2\text{Se}$ : $\frac{19.3}{243} = 0.079$  $\text{H}_2\text{Te}$ : $\frac{23.2}{268} = 0.087$

Four values

For similar bonding, b.p. and $\Delta H_{\text{vap}}$ are proportional

Water has a higher ratio due to different / stronger hydrogen bonding

(c) (i) $P = P_A \times X_A$
The vapour pressure exerted by a gas is proportional to its mole fraction

(ii) Law holds only for similar intermolecular forces / $\text{H}_2\text{S}$ and $\text{H}_2\text{Se}$ both have van der Waals' forces

$\text{H}_2\text{O}$ and $\text{H}_2\text{S}$ have different forces
6. (a) (i) Partition coefficient = \( \frac{[X]_{\text{solvent 1}}}{[X]_{\text{solvent 2}}} \) 

(ii) \( K = \frac{1.0 \times 10^{-2}}{4.0 \times 10^{-3}} = 2.5 \) 

(iii) Let \( x \) mol of iodine be dissolved by the solvent 

Then \( (4.0 \times 10^{-4} - x) \) mol \( I_2 \) remain in 100 cm\(^3\) water 

And \( x \) mol \( I_2 \) are present in 50 cm\(^3\) of solvent 

\[
2.5 = \frac{\text{Concn in solvent}}{\text{Concn in water}} = \frac{20x}{10(4.0 \times 10^{-4} - x)}
\]

This gives \( 20x = 25(4.0 \times 10^{-4} - x) \)
\[
45x = 10^{-2} \\
x = 2.2 \times 10^{-4} \text{ mol}
\]

Hence the concn of \( I_2 \) in the solvent is \( 20 \times 2.2 \times 10^{-4} \text{ mol dm}^{-3} \)

or \( 4.4 \times 10^{-3} \text{ mol dm}^{-3} \) 

(max 6)

(b) (i) The solubility of a gas in a liquid is proportional to the (partial) pressure of the gas 

(ii) Solubility of \( N_2 \) = \( 0.79 \times 23.6 = 18.6 \text{ cm}^3 \text{ dm}^{-3} \) 

Solubility of \( O_2 \) = \( 0.20 \times 48.9 = 9.8 \text{ cm}^3 \text{ dm}^{-3} \) 

(iii) \( \% N_2 \) is \( \frac{18.6}{18.6 + 9.8} = \frac{18.6}{28.4} = 65.5\% \)

And hence \( \% O_2 = 34.5\% \) 

[4]
Spectroscopy

7. (a)

-1 for every line over 3

(b) \[ \text{CH}_3\text{C} - \text{Cl} \]

-1 for every incorrect over 2

(c) (i) Diphenylmethaneone will absorb at lower energy (longer wavelength) (1)

(ii) Energy levels are closer together

hence less energy is required for transitions
(allow longer chromophore / greater delocalisation / conjugation)

(d)

[Diagram showing absorbance vs. wavelength in nm]

[2]
8. (a) (i) A suspension of an organic solid in a hydrocarbon oil / Nujol

(ii) Ethanol shows a strong IR absorption due to \(-\text{OH}\)
It absorbs water which would attack the NaCl plates

(b) \[
\text{Q} \quad \text{C} = \text{N} \quad \text{R} \quad \text{C} = \text{O} \quad \text{S} \quad \text{C} = \text{O} \quad \text{J}
\]

Or ester isomers of the above, NOT \(-\text{OH} / -\text{NH}_2\) containing isomers

(c) (i) Peak is at \(M - 15\), hence \(\text{CH}_3\) has been lost

(ii) \(\text{T} \text{ to } \text{U}\) is a loss of 30, suggests loss of \(\text{CH}_2\text{O}\) or \(-\text{CH}_2\text{NH}_2\)

(iii) Ratio of \(M : M+1\) gives \(n = \frac{0.11 \times 100}{2.5 \times 1.1}\) or 4 carbons

If \(K\) is saturated, it will contain 8 hydrogens (\(\text{C}_4\text{H}_8\text{O}_x\))
This leaves a mass of 32 for the oxygen
Hence \(K\) is \(\text{C}_4\text{H}_8\text{O}_2\)
Transition Elements

9. (a) Labelled diagram is acceptable

Impure copper anode, pure copper cathode
(1)

Copper is transferred to the cathode (or equations)
(1)

CuSO₄(aq) is the electrolyte
(1)

Silver settles as the metal in the anode sludge
(1)

Because $E^\circ$ is more +ve than Cu²⁺
(1)

Ni / Zn goes into solution as M²⁺
(1)

Because their $E^\circ$ is more negative than Cu²⁺
(1)

[max6]

(b) (i) Brass, with zinc; bronze, with tin etc
(1)

(ii) moles of $S_2O_3^{2-} = 0.1 \times 20/1000 = 2 \times 10^{-3}$ mol
(1)

moles of $I_2 = 1 \times 10^{-3}$
(1)

moles of Cu²⁺ = $2 \times 10^{-3}$
(1)

Mass of copper = $63.5 \times 2 \times 10^{-3}$ g
= 0.127 g
(1)

Hence % copper = 50.8%
[4]
10. (a) \([\text{Ar}]3d^4\)

(b) \(\text{Mn(II)}\) colourless OR pale pink
\(\text{Mn(III)}\) red
\(\text{Mn(VI)}\) green
\(\text{Mn(VII)}\) purple

4 correct, 3 marks
3 correct, 2 marks etc

(c) (i) From Data Book: \(4\text{MnO}_4^{2-} - 4\text{e}^- \rightarrow 4\text{MnO}_4^-\) \(E^\circ = 0.56\text{V}\)  
\(5\text{MnO}_4^{2-} + 8\text{H}^+ \rightarrow \text{Mn}^{2+} + 4\text{MnO}_4^- + 4\text{H}_2\text{O}\)  
\(E^\circ_{\text{cell}} = +1.74 - 0.56 = +1.18\text{V}\)

(ii) Oxidation no = +5

\(8\text{H}^+ + 3\text{MnO}_4^{3-} \rightarrow 2\text{MnO}_2 + \text{MnO}_4^- + 4\text{H}_2\text{O}\) (1 for correct formulae, 1 for balancing)