1. Which of the following contains approximately \(6 \times 10^{23}\) molecules?
   A. 16 g oxygen
   B. 40 g neon
   C. 58.5 g sodium chloride
   D. 160 g bromine

2. Which of the following molecules is non-planar?
   A. \(H_2O\)
   B. \(C_2H_4\)
   C. \(C_2H_2\)
   D. \(NH_3\)

3. A mixture of 1 volume of methane and 3 volumes of oxygen is sparked in a closed tube. The equation for the reaction occurring is
   \[CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O\]
   What is the molar composition of the gas mixture at 110°C after the reaction?

<table>
<thead>
<tr>
<th></th>
<th>Methane</th>
<th>Oxygen</th>
<th>Carbon dioxide</th>
<th>Steam</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>C</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>D</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

4. The atomic emission spectrum of hydrogen
   A. provides information about the bond vibrations in the hydrogen molecule
   B. consists of several series of lines, each series converging to a limit at the low frequency end
   C. provides information about the radiation emitted by excited electrons when they gain energy
   D. consists of several series of lines, each series converging to a limit at the high frequency end

5. Which of the following represents the first ionisation energy for bromine?
   A. \(\frac{1}{2}Br_2(l) \rightarrow Br^+(g) + e^-\)
   B. \(Br(g) \rightarrow Br^+(g) + e^-\)
   C. \(\frac{1}{2}Br_2(g) \rightarrow Br^+(g) + e^-\)
   D. \(Br(g) + e^- \rightarrow Br^-(g)\)

6. The energy associated with electromagnetic radiation is directly proportional to the
   A. velocity of the radiation
   B. wavelength of the radiation
   C. reciprocal of the velocity of the radiation
   D. reciprocal of the wavelength of the radiation

7. In which of the following does \(Y\) represent the mean bond dissociation enthalpy for \((O-H)\) in water?
   A. \(H_2O(g) \rightarrow O(g) + H_2(g)\) \(\Delta H = 2 \times Y\)
   B. \(H_2O(g) \rightarrow O(g) + 2H(g)\) \(\Delta H = Y\)
   C. \(H_2O(g) \rightarrow O(g) + H_2(g)\) \(\Delta H = Y\)
   D. \(H_2O(g) \rightarrow O(g) + 2H(g)\) \(\Delta H = 2 \times Y\)

8. What is the concentration of hydrogen ions, in mol\(l^{-1}\), of a solution of pH = 14?
   A. 0
   B. \(10^{-14}\)
   C. 14
   D. \(10^{14}\)

9. In which of the following does the bonding have most ionic character?
   A. Ammonia
   B. Sodium hydride
   C. Silicon hydride
   D. Hydrogen fluoride

[Turn over]
10. The units for $K_f$ for the reaction
\[ \text{N}_2(g) + 3\text{H}_2(g) \rightleftharpoons 2\text{NH}_3(g) \] are
A $\text{mol}^{-1}$
B $\text{mol}^{-1}$
C non-existent
D $\text{mol}^{-2}$

11. In which of the following will an increase in pressure lead to an increase in concentration of the product(s)?
A $\text{H}_2(g) + \text{Cl}_2(g) \rightleftharpoons 2\text{HCl}(g)$
B $2\text{N}_2\text{O}_5(g) \rightleftharpoons 2\text{N}_2\text{O}_4(g) + \text{O}_2(g)$
C $2\text{SO}_2(g) + \text{O}_2(g) \rightleftharpoons 2\text{SO}_3(g)$
D $\text{N}_2\text{O}_4(g) \rightleftharpoons 2\text{NO}_2(g)$

12. 25 cm$^3$ of sodium hydroxide solution require 30 cm$^3$ sulphuric acid (1 mol$^{-1}$) for complete neutralisation. The number of moles of sodium hydroxide neutralised are
A 0.03
B 0.06
C 1.20
D 2.40.

13. Which of the following indicators would you use in the titration of aqueous potassium hydroxide solution with aqueous ethanoic acid solution?
A Phenolphthalein, pH range 8.3–10.0
B Bromothymol blue, pH range 6.0–7.6
C Methyl red, pH range 4.2–6.3
D Methyl orange, pH range 3.1–4.4

14. A solution is made by mixing 100 cm$^3$ CH$_3$COOH (0.1 mol$^{-1}$) and 100 cm$^3$ CH$_3$COONa (0.1 mol$^{-1}$). What will be the effect of diluting this mixture with 50 cm$^3$ water?
A The concentration and pH will decrease significantly.
B The concentration will decrease and the pH will increase significantly.
C The concentration will decrease but the pH will remain fairly constant.
D The concentration and pH will remain fairly constant.

15. Which of the following statements about the benzene molecule is not true?
A It is planar.
B It is susceptible to attack by electrophilic reagents.
C The C—C bonds are equal in length.
D It is readily attacked by bromine.

16. Which of the following is correct?
A CH$_3$OH is a stronger acid than \[ \text{CH}_3\text{OH} \]
B \[ \text{NH}_2 \text{ is a stronger base than } \text{CH}_3\text{NH}_2 \]
C CH$_3$COOH is a stronger acid than \[ \text{HO} \]
D C$_2$H$_5$OH is a stronger base than \[ \text{NH}_3 \]

17. Which of the following will give rise to a secondary alcohol on hydrolysis?
A CH$_3$CH(CH$_3$)OH—O—C—CH$_3$
B CH$_3$CH(CH$_3$)CH$_2$OH—O—C—CH$_3$
C CH$_3$C(CH$_3$)$_2$OH—O—CH
D CH$_3$OH—O—C—CH(CH$_3$)CH$_3$

18. A substance has a molecular formula C$_7$H$_6$O. It is slightly soluble in water, but very soluble in sodium hydroxide solution. It gives no vigorous reaction with sodium carbonate solution. Which of the following functional groups is most likely to be present in this compound?
A Carboxylic
B Phenolic
C Ketonic
D Aldehydic
19. An alcohol did not react with acidified dichromate solution, but gave an alkene when dehydrated with hot concentrated sulphuric acid. This alkene reacted with bromine water to form 1,2-dibromo-2-methylpropane.
Which of the following could have been the alcohol concerned?

CH₃
A CH₃−CH−CH₂OH

OH
B CH₃−CH₂−CH−CH₃

OH
C CH₃−C−CH₃

CH₃
D CH₃−C−CH₃

C₃H₅

20. Which of the following compounds would liberate one mole of hydrogen gas if one mole of it reacts with two moles of sodium?

A C₂H₅OH
B CH₃OHCH₂OH
C CH₃COOH
D CH₃CHO

21. Which of the following can behave as an electrophile?

A C₂H₅NH₂
B HS⁻
C NH₃
D NO₂⁺

22. For the reaction A + B → C, the following data were obtained.

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Initial concentration of A/mol L⁻¹</th>
<th>Initial concentration of B/mol L⁻¹</th>
<th>Initial rate of formation of C/mol L⁻¹ s⁻¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.050</td>
<td>0.050</td>
<td>0.015</td>
</tr>
<tr>
<td>2</td>
<td>0.050</td>
<td>0.100</td>
<td>0.060</td>
</tr>
<tr>
<td>3</td>
<td>0.100</td>
<td>0.100</td>
<td>0.060</td>
</tr>
</tbody>
</table>

The rate law for this reaction is

A rate = k[A]²
B rate = k[A][B]
C rate = k[B]²
D rate = k[A][B]²

23. The reaction A + 2B → C has a rate law of the form

Rate = k[A][B]

If the reaction proceeds by a two step process, then the rate determining step might be

A A + B → intermediate
B B + B → intermediate
C A + B → C
D B + AB → C

24. The rate law for the reaction

2H₂(g) + 2NO(g) → 2H₂O(g) + N₂(g)

can be expressed as either

Rate of production of N₂ = k'[H₂] [NO]² or
Rate of production of H₂O = k''[H₂] [NO]²

Which of the following is true?

A k' = k''
B k' = 2k''
C k'' = 2k'
D The order of the reaction is 4.

[Turn over]
25. The equilibrium constant for a reaction at 298 K is > 10^6.

Which of the following statements about the reaction is true?

A. The activation energy for the forward reaction must be very small.
B. ΔH° for the forward reaction must be negative.
C. ΔG° for the forward reaction must be negative.
D. ΔG° for the forward reaction must be positive.

26. Which of the following is not a redox reaction?

A. IO₄⁻ + 5I⁻ + 6H⁺ → I₂ + 3H₂O
B. 5C₂O₄²⁻ + 2MnO₄⁻ + 16H⁺ → 2Mn²⁺ + 10CO₂
C. 2S₂O₃²⁻ + I⁻ → S₄O₆²⁻ + 2I⁻
D. 2CrO₄²⁻ + 2H⁺ → Cr₂O₇²⁻ + H₂O

27. Which of the following statements best explains the fact that SiH₄ has a higher boiling point than CH₄?

A. Si—H bonds are stronger than C—H bonds.
B. There is stronger hydrogen bonding between SiH₄ molecules than between CH₄ molecules.
C. SiH₄ has a higher molecular weight than CH₄.
D. Methane exists as a gas at room temperature.

28. Which of the following statements regarding a chemical system in equilibrium is never true?

A. The forward reaction and the reverse reaction have both stopped.
B. The concentrations of the reactants are greater than the concentrations of the products.
C. The rate of the forward reaction is equal to the rate of the reverse reaction.
D. The concentrations of the reactants are less than the concentrations of the products.

29. Assuming the symbol [Ar] indicates complete filling of electron shells up to and including argon, the electron configuration of Mn³⁺ is

A. [Ar] 3d⁵
B. [Ar] 3d² 4s²
C. [Ar] 3d³ 4s²
D. [Ar] 3d⁶ 4s¹

30. Which of the following ions contains d-electrons?

A. Ca²⁺
B. V³⁺
C. Se³⁺
D. Ti⁴⁺

The processes in questions 31, 32 and 33 may be placed in one of the following categories. A category may be used once, more than once, or not at all.

A. ΔH positive, ΔS positive
B. ΔH positive, ΔS negative
C. ΔH negative, ΔS positive
D. ΔH negative, ΔS negative

31. The condensation of water vapour.

32. The melting of ice.

33. The burning of liquid petrol.

34. In the electrochemical cell

headed under standard conditions, which of the following is not true? (Refer to page 13 of the Data Booklet.)

A. Oxidation takes place at the chromium electrode.
B. The silver electrode decreases in mass.
C. The potential difference is 1.54 V.
D. Electrons flow from chromium to silver in the external circuit.
35. \( \text{Fe(III)}[\text{Fe(III)}(\text{CN})_6] \rightarrow \text{KFe(II)}[\text{Fe(III)}(\text{CN})_6] \rightarrow \text{K}_2\text{Fe(II)}[\text{Fe(II)}(\text{CN})_6] \)

Berlin Green  Prussian Blue  Everitt’s Salt

To form Prussian Blue, it would be necessary to
A  oxidise Berlin Green and oxidise Everitt’s Salt
B  oxidise Berlin Green and reduce Everitt’s Salt
C  reduce Berlin Green and reduce Everitt’s Salt
D  reduce Berlin Green and oxidise Everitt’s Salt.

36. Which of the following will increase the equilibrium constant for the reaction
\( \text{N}_2\text{O}_4(g) \rightleftharpoons 2\text{NO}_2(g) \)
given that \( \Delta H \), left to right, is positive?
A  Use of a catalyst
B  Increase of pressure
C  Increase of temperature
D  Decrease of temperature

37. Which of the following statements is not likely to be true of a transition element M?
A  It has a fixed valency.
B  It forms a stable ion \( \text{M}^{2+} \).
C  It forms coloured compounds.
D  Its atoms contain partly filled d-orbitals.

38.

The reduction of \( \text{Al}_2\text{O}_3 \) to Al is thermodynamically feasible at 2000 K using
A  calcium
B  magnesium
C  manganese
D  titanium.

[Turn over]
39. The boxes in the grid below show the names of certain chemical compounds.

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Aluminium chloride</td>
<td>Sodium ethanoate</td>
<td>Ammonium chloride</td>
</tr>
<tr>
<td>D</td>
<td>Sodium chloride</td>
<td>Copper(ll) sulphate</td>
<td>Potassium nitrate</td>
</tr>
</tbody>
</table>

(a) Identify the compound(s) whose aqueous solution(s) has (have) a pH of less than 7.

(b) If an aqueous sodium carbonate solution is added to an aqueous solution of each of the above compounds, identify which will give a precipitate.

40. The boxes in the grid below show the equations for certain chemical reactions.

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( \text{Cl(g)} + e \rightarrow \text{Cl(g)} )</td>
<td>( \text{Na(g)} \rightarrow \text{Na}^+ (g) + e^- )</td>
<td>( \text{Na(s)} \rightarrow \text{Na(g)} )</td>
</tr>
<tr>
<td>D</td>
<td>( \text{Na(s)} + \frac{1}{2}\text{Cl}_2(g) \rightarrow \text{Na}^+ \text{Cl}^- (s) )</td>
<td>( \text{Na}^+ (g) + \text{Cl}^- (g) \rightarrow \text{Na}^+ \text{Cl}^- (s) )</td>
<td>( \frac{1}{2}\text{Cl}_2(g) \rightarrow \text{Cl(g)} )</td>
</tr>
</tbody>
</table>

Identify the endothermic reaction(s).

[Turn over]
41. The boxes in the grid below show the formulae of organic compounds used in industry.

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Chemical Structure A" /></td>
<td><img src="image2" alt="Chemical Structure B" /></td>
<td><img src="image3" alt="Chemical Structure C" /></td>
</tr>
<tr>
<td>D</td>
<td>E</td>
<td>F</td>
</tr>
<tr>
<td><img src="image4" alt="Chemical Structure D" /></td>
<td><img src="image5" alt="Chemical Structure E" /></td>
<td><img src="image6" alt="Chemical Structure F" /></td>
</tr>
</tbody>
</table>

Identify, in each case, a compound used to manufacture (by the shortest route)

(a) explosives
(b) a thermosetting plastic
(c) an ionic soapless detergent
(d) an addition polymer.
1. Haloalkanes are extremely versatile organic compounds, and are widely used in syntheses and preparations as indicated in the following flow diagram.

![Flow diagram](image)

\[ R = \text{alkyl group} \]

(a) Name the type of reaction involved in reactions 1 to 4.

(b) Why can haloalkanes take part in the type of reaction in (a)?

(c) How is the reagent OR\(^-\) obtained from an alcohol?

(d) 1-bromopropane was used as the starting material for the preparation of carboxylic acids. Name the carboxylic acid formed

(i) via route 1,

(ii) via route 3.

2. Use the data on page 14 of the Data Booklet to calculate the pH of a solution of propanoic acid of concentration 10\(^{-1}\) mol\(\text{l}^{-1}\).
Examine the diagram above, which shows the main natural processes affecting ozone in the stratosphere, and answer the questions below.

(a) How does the ozone in the stratosphere act as an essential filter for solar radiation?  

(b) The production of nitric oxide (nitrogen monoxide), NO, from nitrous oxide (dinitrogen monoxide), N₂O, in the lower stratosphere requires reaction with an oxygen atom in an excited state. What is meant by an "excited state"?  

(c) Why is the nitric oxide regarded as a catalyst in the destruction of the ozone layer?  

(d) Why would the presence of large numbers of aircraft flying in the stratosphere be a threat to the ozone layer?
4. Solid magnesium chloride exists in two forms—
anhydrous(MgCl₂) and hydrated(MgCl₂·6H₂O).

(a) Calculate the enthalpy change for the process
MgCl₂(s) → Mg²⁺(aq) + 2Cl⁻(aq)
given the following data:
Mg²⁺(g) → Mg²⁺(aq)  ΔH = −1920 kJ mol⁻¹
Cl⁻(g) → Cl⁻(aq)  ΔH = −364 kJ mol⁻¹
Lattice enthalpy (anhydrous magnesium chloride) = 2493 kJ mol⁻¹

(b) Calculate the enthalpy change for converting anhydrous magnesium chloride to hydrated
magnesium chloride, given the following enthalpies of formation:
ΔH_f(hydrated magnesium chloride) = −2500 kJ mol⁻¹
ΔH_f(anhydrous magnesium chloride) = −642 kJ mol⁻¹
ΔH_f(water) = −286 kJ mol⁻¹

5. Chlorine and fluorine react to produce a compound of formula ClF₃. This molecule contains three
chlorine-fluorine single bonds. Each fluorine atom contributes one electron to the bonding.

(a) How many electron pairs (both bonded and non-bonded) surround the central chlorine atom
in the molecule?

(b) What would be the three-dimensional arrangement of electron pairs (both bonded and non-
bonded) around the chlorine atom?

(c) The fluorine atoms may occupy different positions in this shape giving rise to three possible
shapes for the molecule. Draw two of these, showing the angles between the bonds.
6. In a catalytic reformer, straight chain alkanes are converted to branched chains, cycloalkanes and aromatic hydrocarbons. Consider the sequence shown below.

octane  
\[ \xrightarrow{A} \]
2,3-dimethylhexane  
\[ \xrightarrow{B} \]
1,2-dimethylcyclohexane + hydrogen  
\[ \xrightarrow{C} \]
1,2-dimethylbenzene (o-xylene) + hydrogen

(a) Use the data in the table below to calculate $\Delta S^\circ$ for the conversion of octane to o-xylene and hydrogen at 298 K.

<table>
<thead>
<tr>
<th>Compound</th>
<th>$S^\circ / JK^{-1} mol^{-1}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>octane</td>
<td>463</td>
</tr>
<tr>
<td>o-xylene</td>
<td>352</td>
</tr>
<tr>
<td>hydrogen</td>
<td>131</td>
</tr>
</tbody>
</table>

(b) Calculate the minimum temperature at which the conversion in (a) becomes thermodynamically feasible, given that $\Delta H^\circ = 227 \text{ kJ mol}^{-1}$.

(c) Explain why the conversion in (a) can be achieved at or above the temperature calculated in part (b), despite the fact that the equilibrium constant for reaction A is very much less than 1 at this temperature.

| Turn over |
7. The d-orbitals in an isolated ion or atom of a transition metal are degenerate. As soon as an ion is surrounded by ligands, these orbitals are no longer degenerate but are split into two groups having different energies. In a complex ion with octahedral arrangement of ligands, $[MX_6]^n_\text{c}$, the relative energies of the d-orbitals are as shown below.

(M = transition metal, X = ligand, n = charge on the complex ion)

\[
\begin{array}{c}
\text{Energy} \\
\downarrow \\
\Delta \\
\end{array}
\]

The energy difference, $\Delta$, between the two groups of d-orbitals depends on the ligand X. The splitting ability of some ligands has been observed to be as follows.

$\text{H}_2\text{O} < \text{NH}_3 < \text{CN}^-$

The colour of many transition metal complex ions can be explained by electronic transitions between the two sets of d-orbitals.

(a) Explain why $[\text{Fe(H}_2\text{O})_6]^{2+}$ is green.

(b) Predict the colour of $[\text{Fe(CN)}_6]^{4-}$, giving reasons for your answer.

Substances which are weakly attracted by a magnetic field are called paramagnetic substances. Paramagnetism is caused by the presence of unpaired electrons, as there is a small magnetic field created by a single spinning electron.

(c) Fe(II), which is present in both $[\text{Fe(H}_2\text{O})_6]^{2+}$ and $[\text{Fe(CN)}_6]^{4-}$, has six d-electrons. Of these two complex ions, only $[\text{Fe(H}_2\text{O})_6]^{2+}$ is paramagnetic.

Using d-orbital diagrams, similar to the one above, show the d-electron arrangements of Fe(II) in each of these two complex ions and suggest why one complex ion is paramagnetic while the other is not.

8. 1.8 g of iron(II) ammonium sulphate, $\text{Fe(NH}_4\text{)}_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$, was dissolved in 35 cm$^3$ of distilled water. The solution was then diluted to 50 cm$^3$ using dilute sulphuric acid. The final solution was titrated against potassium permanganate solution and 40 cm$^3$ of the permanganate solution was required to reach the end point at which all the iron(II) had been converted to iron(III).

Calculate the concentration of the potassium permanganate solution.
9. Aluminium oxide is obtained from bauxite as shown in the flow diagram below.

(a) On what property of oxides does the initial separation of aluminium oxide and iron(III) oxide depend? 

(b) What role does carbon dioxide play in the overall process? 

(c) Identify the by-products of the process. 

(d) Suggest one addition to the above flow diagram which would make the process more economical.

Marks

<table>
<thead>
<tr>
<th>Question</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>1</td>
</tr>
<tr>
<td>(b)</td>
<td>2</td>
</tr>
<tr>
<td>(c)</td>
<td>2</td>
</tr>
<tr>
<td>(d)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>(6)</td>
</tr>
</tbody>
</table>

10. A company decided to produce relatively cheap platinum jewellery. 

Their plan was to make plastic brooches or ear-rings which were then to be sprayed, first with silver(I) nitrate solution and then with a reducing agent. Electrolysis in a solution of a platinum(II) salt would then build up a coating of platinum on each item. The finished items were to look like solid platinum, but would be mainly plastic. 

It was planned that electrolysis for 15 hours would deposit a total of 0.25 kg of platinum. 

(a) Why was it necessary to spray the plastic items with silver(I) nitrate solution and then a reducing agent? 

(b) Suggest a suitable reducing agent. 

(c) Calculate the average current to be used in the electrolysis.

Marks

<table>
<thead>
<tr>
<th>Question</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>2</td>
</tr>
<tr>
<td>(b)</td>
<td>1</td>
</tr>
<tr>
<td>(c)</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>(6)</td>
</tr>
</tbody>
</table>
11. The following is an extract from *Opportunities in Chemistry* – often referred to as the Pimentel Report, published in America by the National Academy Press in 1985.

"Since the 1960s, we've known that high levels of cholesterol correlate with heart ailments, the major cause of death in the United States. What we need is a Pac-Man to chomp up the cholesterol in the blood and reduce "hardening" of the arteries that carry blood from the heart (atherosclerosis). Now a lowly fungus – not unlike the famous mould, penicillium – may have shown us one.

A normally functioning human cell uses a dual system for meeting its cholesterol needs. First, the cell has its own factory to manufacture cholesterol. In addition, the cell's exterior has a number of lipoprotein receptors that can grab onto cholesterol-containing lipoproteins as they pass by in the bloodstream and pull them inside. The cell fixes the number of these Pac-Man-like receptors so that just the right amount of imported cholesterol is added to the factory-made product. If the inner cell cholesterol level falls too low, more receptors are added to extract more from the blood stream.

There's an idea! If the cell's cholesterol factory could be slowed down, would the cell produce more receptors to make up the difference from the blood stream supply? A chance to test this scenario came when a biochemist discovered that certain fungi produced something that inhibited cholesterol synthesis. Chemists joined in the plot, purified the effective compound, determined its structure, and named it COMPACTIN. Knowing its structure, chemists were able to synthesize close relatives of compactin that are even more potent. Chemical tests with these new chemicals indicate that the scheme works as planned."

Read the passage above, and answer the questions below.

(a) What determines the number of lipoprotein receptors on the exterior of human cells? 2
(b) What is an inhibitor? 1
(c) Explain how the inhibitor inside the cells reduces the level of cholesterol in the blood. 2

(5)

12. Examine the reaction mechanism below:

\[
A + B \xrightarrow{\text{fast}} C \quad \text{step 1}
\]

\[
2B + C \xrightarrow{\text{slow}} D + E \quad \text{step 2}
\]

Overall: \( A + 3B \longrightarrow D + E \)

How would the rate of reaction depend on the concentrations of

(a) A and 1
(b) B? 1

(2)

[0500/481]
13. Two aliphatic compounds A and B, which contain carbon, hydrogen and oxygen only, are isomers. They can both be oxidised as follows.

\[ \text{A} \xrightarrow{\text{oxidation}} \text{C} \]
\[ \text{B} \xrightarrow{\text{oxidation}} \text{D} \]

The table below shows the wavenumbers of the main absorptions in the infra red spectra caused by the functional groups in compounds A to D, between 1500 and 4000 cm\(^{-1}\) (absorptions caused by C–H bonds in alkyl components have been omitted):

<table>
<thead>
<tr>
<th>Compound</th>
<th>Wavenumber(s)/cm(^{-1})</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>3300</td>
</tr>
<tr>
<td>B</td>
<td>3350</td>
</tr>
<tr>
<td>C</td>
<td>2750 1730</td>
</tr>
<tr>
<td>D</td>
<td>1700</td>
</tr>
</tbody>
</table>

In answering the following questions, you are advised to consult the data on page 15 of the Data Booklet.

(a) Examine the table above and identify the functional groups present in:
   (i) A and B,  
   (ii) C,  
   (iii) D.  
   
(b) Describe a chemical test you could use to provide support for your answers to (ii) and (iii) of part (a).
   
(c) Compound C will undergo further oxidation to produce compound E. Estimate the wavenumbers of the main infra red absorptions caused by the functional groups in compound E (only those between 1500 and 4000 cm\(^{-1}\)).

[END OF QUESTION PAPER]