2012 Senior External Examination

Chemistry
Monday 5 November 2012
Paper One — Question and response book
9 am to 11:40 am

Time allowed
• Perusal time: 10 minutes
• Working time: 2 hours 30 minutes

Examination materials provided
• Paper One — Question and response book
• Paper One Part A — Multiple-choice response sheet
• Paper One — Resource book

Equipment allowed
• QSA-approved equipment
• non-programmable calculator

Directions
Do not write in this book during perusal time.
Paper One has two parts:
• Part A — Knowledge of subject matter:
  Section 1 — Multiple choice (attempt all questions)
  Section 2 — Short response (attempt all questions)
• Part B — Scientific processes (attempt four questions only)

Suggested time allocation
• Part A: 1 hour 50 minutes
• Part B: 40 minutes

Assessment
Assessment standards are at the end of this book.

After the examination session
The supervisor will collect this book when you leave.
Planning space
Part A — Knowledge of subject matter

Part A assesses knowledge of subject matter and its simple application based on the eight topics in the Chemistry Senior External Syllabus 1998.

Part A is worth 80 marks.

Suggested time allocation: 1 hour 50 minutes.

Section 1 — Multiple choice

Section 1 has 10 questions of equal value. Attempt all questions.

Each question contains four options. Select the option that you think is correct or is the best option. Respond on the multiple-choice response sheet.

**Question 1**

If a teaspoon of sugar was added to a beaker containing a saturated sugar solution, which of the following would be observed?

A All of the added sugar would dissolve.
B The solution would become a little sweeter.
C Only some of the added sugar would dissolve.
D More sugar crystals than before would appear in the beaker.

**Question 2**

The structure below represents a biological molecule.

![Chemical structure](image)

The specific type of covalent bond indicated is found in

A fats.
B esters.
C proteins.
D carbohydrates.
Question 3
A section of the periodic table has had the chemical symbols replaced by letters.

```
  Z
  S  Y
  W
```

Which of the following elements is likely to have the lowest first ionisation energy?

A  Element S  
B  Element W  
C  Element Y  
D  Element Z  

Question 4
The shape of the molecule Boron trifluoride, BF₃, is best described as

A  pyramidal.  
B  tetrahedral.  
C  bent triatomic.  
D  planar trigonal.  

Question 5
The mass of calcium hydroxide needed to make 1.0 L of 2.0 M solution would be

A  148.0 g.  
B  74.0 g.  
C  29.6 g.  
D  22.8 g.  

Question 6
An element with the electron configuration of 1s² 2s² 2p⁶ 3s¹ would be classified as a

A  metal.  
B  metalloid.  
C  non metal.  
D  noble gas.  

---

2  2012 Chemistry — Paper One — Question and response book
Question 7

Phosphorus chloride, PCl₅, decomposes to form phosphorus chloride (PCl₃) and chlorine (Cl₂) according to the equation

\[ \text{PCl}_5(\text{g}) \rightleftharpoons \text{PCl}_3(\text{g}) + \text{Cl}_2(\text{g}) \]

Four different flasks, A, B, C and D, at the same temperature, contain a mixture of PCl₅, PCl₃ and Cl₂. The concentration, in mol L\(^{-1}\), of these components in each of the flasks is shown below.

In three of the four flasks, the mixture of gases is at equilibrium.

In which flask is the mixture of gases not at equilibrium?

<table>
<thead>
<tr>
<th>[PCl₅(g)]</th>
<th>[PCl₃(g)]</th>
<th>[Cl₂(g)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A 0.15</td>
<td>0.20</td>
<td>0.30</td>
</tr>
<tr>
<td>B 0.20</td>
<td>0.15</td>
<td>0.15</td>
</tr>
<tr>
<td>C 0.10</td>
<td>0.10</td>
<td>0.40</td>
</tr>
<tr>
<td>D 0.30</td>
<td>0.80</td>
<td>0.15</td>
</tr>
</tbody>
</table>

Question 8

Which of the following graphs correctly shows the relationship between the volume and kelvin temperature of a fixed amount of gas (at constant pressure)?

A

B

C

D

Question 9

Which of the following chemical changes can be considered as an oxidation process?

A  MnO₂ → Mn\(^{2+}\)
B  MnO₄\(^-\) → Mn\(^{2+}\)
C  MnO₂ → MnO₄\(^-\)
D  MnO₄\(^-\) → MnO₄\(^{2-}\)
**Question 10**

The following reaction can occur to completion in aqueous solution.

\[ \text{CH}_3\text{Cl}^{\text{(aq)}} + \text{OH}^-^{\text{(aq)}} \rightarrow \text{CH}_3\text{OH}^{\text{(aq)}} + \text{Cl}^-^{\text{(aq)}} \]

The diagram below shows the energy change during this process.

A reaction can occur between a CH\(_3\)Cl molecule and an OH\(^-\) ion

A. every time they collide.

B. only when they collide with exactly the energy of X.

C. only when they collide with exactly the energy of Z.

D. only when they collide with an energy greater than or equal to energy X.

**End of Section 1**
Section 2 — Short response

Section 2 has eight questions. Attempt all questions.

Write your responses in the spaces provided. You must show all working where applicable.

If you need more space for a response, continue on pages 25 and 26 of this book.
Label any continued response with the question number.

Question 11 — Materials: Properties, bonding and structure

a. Define the following terms:

   i. element

   ii. single covalent bond

(2 marks)

b. Explain why CO₂ is a gas at 25 °C while SiO₂ is a crystalline substance with a high melting point at the same temperature.

(3 marks)

c. The following statement contains four mistakes.

“The symbol for the element potassium is Po, as is clearly illustrated in the equation for the compound potassium chlorine, which is PoCl.”

Complete the following table to show each mistake and its correction.

<table>
<thead>
<tr>
<th>Mistake</th>
<th>Correction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

(2 marks)
d. Explain why metals conduct electricity in both solid and molten states but ionic substances can only conduct electricity in the molten state.

..........................................................................................................
..........................................................................................................
..........................................................................................................
..........................................................................................................
..........................................................................................................
..........................................................................................................
..........................................................................................................
..........................................................................................................
..........................................................................................................
(2 marks)

e. Give the formula for the nitrate ion.

..........................................................................................................
(1 mark)

f. Name the substance represented by the formula Fe₂O₃.

..........................................................................................................
(1 mark)

**Question 12 — Reacting quantities and chemical analysis**

a. Explain the following terms:

i. mole

..........................................................................................................
..........................................................................................................
..........................................................................................................

ii. molecular formula

..........................................................................................................
..........................................................................................................
..........................................................................................................
..........................................................................................................

(2 marks)

b. Rewrite the following as a balanced equation.

\[ \text{Ca}_3(\text{PO}_4)_{2(s)} + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{CaSO}_4(s) + \text{H}_3\text{PO}_4(\text{aq}) \]

..........................................................................................................
(2 marks)
c. Calculate the mass of 1.5 mole of aluminium hydroxide $\text{Al(OH)}_3$.

...................................................................................................................................................
...................................................................................................................................................
...................................................................................................................................................

(2 marks)

d. A compound was analysed and found to have the following composition by mass.

- Carbon 23.5%
- Hydrogen 1.9%
- Fluorine 74.6%

What is the empirical formula of this compound?

...................................................................................................................................................
...................................................................................................................................................
...................................................................................................................................................
...................................................................................................................................................
...................................................................................................................................................
...................................................................................................................................................
...................................................................................................................................................
...................................................................................................................................................
...................................................................................................................................................

(3 marks)

e. When a spark is applied, hydrogen gas reacts with oxygen gas to produce water vapour according to the following equation.

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

If a mixture consisting of 300 mL hydrogen and 200 mL oxygen is ignited, what is the volume and composition of the final product?

(Assume all volumes are measured at 100 °C and 1 atmosphere pressure.)

...................................................................................................................................................
...................................................................................................................................................
...................................................................................................................................................
...................................................................................................................................................
...................................................................................................................................................
...................................................................................................................................................

(2 marks)
Question 13 — Oxidation and reduction

a. Describe the following:
   i. oxidation

   ..........................................................................................................
   ..........................................................................................................

   ii. the purpose of a salt bridge

   ..........................................................................................................
   ..........................................................................................................

   (2 marks)

b. Determine the oxidation number of Cr in \( \text{K}_2\text{Cr}_2\text{O}_7 \).

   ..........................................................................................................

   (1 mark)

c. Identify the reducing agent in the following chemical reaction. Explain your choice.
   \[
   \text{KIO}_4(\text{aq}) + 7\text{KI}(\text{aq}) + \text{HCl}(\text{aq}) \rightarrow 8\text{KCl}(\text{aq}) + 4\text{I}_2(\text{s}) + 4\text{H}_2\text{O}(\text{l})
   \]

   ..........................................................................................................
   ..........................................................................................................
   ..........................................................................................................
   ..........................................................................................................

   (2 marks)

d. State one way in which an electrolytic cell differs from a voltaic (galvanic) cell.

   ..........................................................................................................

   (1 mark)

e. A group of students set up an electrolytic cell in order to obtain pure copper from an impure sample.
   What mass of copper will be formed on the pure copper cathode if a 2.5 ampere current is run through the cell for five hours?
   (1 ampere = 1 coulomb sec\(^{-1}\))

   ..........................................................................................................
   ..........................................................................................................
   ..........................................................................................................
   ..........................................................................................................
   ..........................................................................................................

   (2 marks)
Question 14 — Organic chemistry

a. Explain the following terms:
   i. addition polymerisation

   ........................................................................................................
   ........................................................................................................
   ........................................................................................................
   (2 marks)

   ii. homologous series

   ........................................................................................................
   ........................................................................................................
   ........................................................................................................
   (2 marks)

b. Draw two structural isomers of the molecular formula C₄H₁₀O.

   (2 marks)

c. Draw the structure of propanone.

   (1 mark)

d. Name the organic substance with the following structure.

   (1 mark)
e. The following structure is formed as a first step in an elimination polymerisation reaction.

![Structure](image)

Draw the structures of the 2 monomers involved.

<table>
<thead>
<tr>
<th>Species</th>
<th>Electron configuration</th>
<th>Element</th>
<th>Period</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>A neutral atom</td>
<td>1s$^2$.........4p$^3$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>An ion with one negative charge</td>
<td>1s$^2$ ........3p$^6$</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Question 15 — Chemical periodicity**

a. For each of the following electron configurations, identify the element and state its period or group in the periodic table.

b. State the relationship between the number of valence electrons for an element and its group in the periodic table.

c. Name:
   i. an acidic oxide
   ii. the group of elements for which the outermost energy level is full
Question 16 — Gases and the atmosphere

a. Under what conditions is the behaviour of a real gas likely to approach the behaviour of an ideal gas?

.............................................................................................................................................

.............................................................................................................................................

.............................................................................................................................................

(1 mark)

b. 0.453 mol of a gas which fills a 15.0 L container exerts a pressure of 1.24 atm on the container walls. What is the temperature of the gas?

.............................................................................................................................................

.............................................................................................................................................

.............................................................................................................................................

.............................................................................................................................................

(1 mark)

c. Sketch a graph to show the relationship between the volume of a given mass of gas at constant temperature under different conditions of pressure.

.................................................................

.................................................................

.................................................................

.................................................................

(1 mark)

d. A gaseous mixture contains 16 g of methane (CH₄) together with 16 g of oxygen (O₂). The partial pressure of the methane is 50 kPa. Calculate the partial pressure of the oxygen.

.............................................................................................................................................

.............................................................................................................................................

.............................................................................................................................................

.............................................................................................................................................

.............................................................................................................................................

(2 marks)
Question 17 — Energy and rates of chemical reactions

a. Define the following terms:

i. activation energy

ii. combustion

(2 marks)

b. What is the change in enthalpy associated with the formation of 50 g of nitrogen gas according to the following equation?

\[
2\text{NH}_3(g) + 3\text{N}_2\text{O}(g) \rightarrow 4\text{N}_2(g) + 3\text{H}_2\text{O}(g) \quad \Delta H = -1010\text{kJ}
\]

(2 marks)

c. Explain how a slight increase in temperature can cause a significant increase in the rate of exothermic reactions.

(2 marks)
d. Use appropriate data from the table below to calculate the change in enthalpy associated with the following chemical change and state whether the reaction is exothermic or endothermic.

\[ \text{C}_6\text{H}_{12}\text{O}_6(s) + 6\text{O}_2(g) \rightarrow 6\text{CO}_2(g) + 6\text{H}_2\text{O}(g) \]

<table>
<thead>
<tr>
<th>Substance</th>
<th>Formula</th>
<th>( \Delta H^\circ ) (kJ mol(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>acetylene</td>
<td>\text{C}_2\text{H}_2(g)</td>
<td>226.7</td>
</tr>
<tr>
<td>ammonia</td>
<td>\text{NH}_3(aq)</td>
<td>-80.7</td>
</tr>
<tr>
<td>benzene</td>
<td>\text{C}_6\text{H}_6(l)</td>
<td>49.0</td>
</tr>
<tr>
<td>carbon dioxide (gas)</td>
<td>\text{CO}_2(g)</td>
<td>-393.5</td>
</tr>
<tr>
<td>carbon dioxide (liquid)</td>
<td>\text{CO}_2(l)</td>
<td>-413.8</td>
</tr>
<tr>
<td>carbon monoxide</td>
<td>\text{CO}(g)</td>
<td>-110.0</td>
</tr>
<tr>
<td>ethane</td>
<td>\text{C}_2\text{H}_6(g)</td>
<td>-84.7</td>
</tr>
<tr>
<td>glucose</td>
<td>\text{C}<em>6\text{H}</em>{12}\text{O}_6(s)</td>
<td>-1260.0</td>
</tr>
<tr>
<td>methane</td>
<td>\text{CH}_4(g)</td>
<td>-74.85</td>
</tr>
<tr>
<td>sucrose</td>
<td>\text{C}<em>{12}\text{H}</em>{22}\text{O}_{11}(s)</td>
<td>-2221.0</td>
</tr>
<tr>
<td>water</td>
<td>\text{H}_2\text{O}(l)</td>
<td>-285.8</td>
</tr>
<tr>
<td>water vapour</td>
<td>\text{H}_2\text{O}(g)</td>
<td>-241.8</td>
</tr>
</tbody>
</table>

(2 marks)
Question 18 — Chemical equilibrium

a. Explain the differences between:

i. dilute and weak acids

ii. steady state and dynamic equilibrium

(4 marks)

b. The graph below shows the variation in concentration of reactant and products as a function of time for the following closed system.

\[ \text{COCl}_2(g) \rightleftharpoons \text{Cl}_2(g) + \text{CO}(g) \quad \Delta H = +108 \text{ kJ} \]

Identify and explain any change in conditions at the 4 minute mark that has shaped the curves during the time the system was observed.

(2 marks)
c. A soft drink has a pH of 3 and black coffee has a pH of 5. Compare the acidity of the two solutions.

..........................................................................................................
..........................................................................................................
..........................................................................................................
..........................................................................................................
..........................................................................................................
..........................................................................................................

(2 marks)

d. At a particular temperature, 8.0 mol NO$_2$ is placed into an empty 1.0 L container and the NO$_2$ dissociates according to the following reaction.

\[ 2\text{NO}_2(g) \rightleftharpoons 2\text{NO}(g) + \text{O}_2(g) \]

At equilibrium, the concentration of NO is 2.0 M.
Calculate the value of the equilibrium constant at that particular temperature.

..........................................................................................................
..........................................................................................................
..........................................................................................................
..........................................................................................................
..........................................................................................................
..........................................................................................................
..........................................................................................................
..........................................................................................................
..........................................................................................................
..........................................................................................................
..........................................................................................................
..........................................................................................................

(3 marks)

e. Find the pH of the solution which results from dissolving 1.0 g of NaOH in 1.0 L of pure water.

..........................................................................................................
..........................................................................................................
..........................................................................................................
..........................................................................................................
..........................................................................................................
..........................................................................................................
..........................................................................................................

(2 marks)

End of Section 2

End of Part A
Question 1

A solid that forms as a product of a chemical reaction between two aqueous solutions is called a precipitate.

A student mixes 5 mL each of 0.1 M solution of substances A and B, and obtains the following results.

<table>
<thead>
<tr>
<th>Trial</th>
<th>Solution A</th>
<th>Solution B</th>
<th>Results of mixing A and B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ba(NO₃)₂</td>
<td>Na₂SO₄</td>
<td>white precipitate forms</td>
</tr>
<tr>
<td>2</td>
<td>Ba(NO₃)₂</td>
<td>Al₂(SO₄)₃</td>
<td>white precipitate forms</td>
</tr>
<tr>
<td>3</td>
<td>Ba(NO₃)₂</td>
<td>Mg(NO₃)₂</td>
<td>no precipitate</td>
</tr>
<tr>
<td>4</td>
<td>Ba(NO₃)₂</td>
<td>MgCl₂</td>
<td>no precipitate</td>
</tr>
<tr>
<td>5</td>
<td>Ba(NO₃)₂</td>
<td>AlCl₃</td>
<td>no precipitate</td>
</tr>
<tr>
<td>6</td>
<td>Na₂SO₄</td>
<td>Al₂(SO₄)₃</td>
<td>no precipitate</td>
</tr>
<tr>
<td>7</td>
<td>Na₂SO₄</td>
<td>Mg(NO₃)₂</td>
<td>no precipitate</td>
</tr>
<tr>
<td>8</td>
<td>Na₂SO₄</td>
<td>MgCl₂</td>
<td>no precipitate</td>
</tr>
<tr>
<td>9</td>
<td>Na₂SO₄</td>
<td>AlCl₃</td>
<td>no precipitate</td>
</tr>
<tr>
<td>10</td>
<td>Al₂(SO₄)₃</td>
<td>Mg(NO₃)₂</td>
<td>no precipitate</td>
</tr>
<tr>
<td>11</td>
<td>Al₂(SO₄)₃</td>
<td>MgCl₂</td>
<td>no precipitate</td>
</tr>
<tr>
<td>12</td>
<td>Al₂(SO₄)₃</td>
<td>AlCl₃</td>
<td>no precipitate</td>
</tr>
<tr>
<td>13</td>
<td>Mg(NO₃)₂</td>
<td>MgCl₂</td>
<td>no precipitate</td>
</tr>
<tr>
<td>14</td>
<td>Mg(NO₃)₂</td>
<td>AlCl₃</td>
<td>no precipitate</td>
</tr>
<tr>
<td>15</td>
<td>MgCl₂</td>
<td>AlCl₃</td>
<td>no precipitate</td>
</tr>
<tr>
<td>16</td>
<td>KCl</td>
<td>MgCl₂</td>
<td>no precipitate</td>
</tr>
<tr>
<td>17</td>
<td>KCl</td>
<td>Na₂SO₄</td>
<td>no precipitate</td>
</tr>
<tr>
<td>18</td>
<td>KCl</td>
<td>NaOH</td>
<td>no precipitate</td>
</tr>
<tr>
<td>19</td>
<td>KCl</td>
<td>BaCl₂</td>
<td>no precipitate</td>
</tr>
<tr>
<td>20</td>
<td>KCl</td>
<td>MgSO₄</td>
<td>no precipitate</td>
</tr>
<tr>
<td>21</td>
<td>MgCl₂</td>
<td>Na₂SO₄</td>
<td>no precipitate</td>
</tr>
<tr>
<td>22</td>
<td>MgCl₂</td>
<td>NaOH</td>
<td>white precipitate forms</td>
</tr>
<tr>
<td>23</td>
<td>MgCl₂</td>
<td>BaCl₂</td>
<td>no precipitate</td>
</tr>
<tr>
<td>24</td>
<td>MgCl₂</td>
<td>MgSO₄</td>
<td>no precipitate</td>
</tr>
<tr>
<td>25</td>
<td>Na₂SO₄</td>
<td>NaOH</td>
<td>no precipitate</td>
</tr>
<tr>
<td>26</td>
<td>Na₂SO₄</td>
<td>BaCl₂</td>
<td>white precipitate forms</td>
</tr>
<tr>
<td>27</td>
<td>Na₂SO₄</td>
<td>MgSO₄</td>
<td>no precipitate</td>
</tr>
<tr>
<td>28</td>
<td>NaOH</td>
<td>BaCl₂</td>
<td>no precipitate</td>
</tr>
<tr>
<td>29</td>
<td>NaOH</td>
<td>MgSO₄</td>
<td>white precipitate forms</td>
</tr>
<tr>
<td>30</td>
<td>BaCl₂</td>
<td>MgSO₄</td>
<td>white precipitate forms</td>
</tr>
</tbody>
</table>
a. Use the results in the table on the previous page to explain why a precipitate did not form in:

i. Trial 3:

ii. Trial 4:

b. Use the results in the table on the previous page to complete the following.

<table>
<thead>
<tr>
<th>Trial</th>
<th>Formula of precipitate</th>
<th>Reason for choice</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>29</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

c. Write an ionic equation to represent the chemical reaction in:

i. Trial 22:

ii. Trial 2:
Question 2

After reading in a textbook that “acid-base reactions are exothermic”, a student decided to design a scientific investigation relating to that topic.

a. Formulate a hypothesis relevant to the topic.

b. List the apparatus required.

c. In point form, describe the method employed.

d. Identify one safety issue.

e. What collected data would support the above hypothesis?
Question 3

Citric acid in fruit juice can be determined by a reaction with a solution of sodium hydroxide using a suitable indicator to detect the end-point. The reaction occurring will be:

\[
\text{C}_3\text{H}_5\text{O(COOH)}_{3(\text{aq})} + 3\text{OH}^-_{(\text{aq})} \rightarrow \text{C}_3\text{H}_5\text{O(COOO)}_{3(\text{aq})}^{3-} + 3\text{H}_2\text{O(1)}
\]

In such an experiment, 10 mL of a commercial fruit juice was poured into a clean conical flask and diluted with 30 mL of distilled water. Three drops of phenolphthalein indicator were added and the diluted fruit juice was titrated with 0.5 mol L\(^{-1}\) sodium hydroxide. The procedure was repeated three more times to obtain the following data.

<table>
<thead>
<tr>
<th>Titration</th>
<th>Burette reading (mL)</th>
<th>Titre (mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Initial</td>
<td>Final</td>
</tr>
<tr>
<td>Trial</td>
<td>0.8</td>
<td>18.9</td>
</tr>
<tr>
<td>1</td>
<td>18.9</td>
<td>33.9</td>
</tr>
<tr>
<td>2</td>
<td>2.5</td>
<td>17.6</td>
</tr>
<tr>
<td>3</td>
<td>17.6</td>
<td>32.8</td>
</tr>
</tbody>
</table>

a. Why would phenolphthalein be chosen as a suitable indicator for the above titration?

b. What is the purpose of the trial titration?

c. Why are the titre values different for titrations 1, 2 and 3?

---

Question 3 continues overleaf
d. What is the concentration of citric acid in the fruit juice?
Question 4

The following raw materials are available in their standard states in the laboratory at room temperature.

\[
\begin{align*}
\text{H} & \text{C} = \text{C} & \text{H} & \quad \text{H}_2\text{O} & \quad \text{HBr} & \quad \text{NaOH} \\
\text{H} & \quad \text{C} & \quad \text{H} & \quad \text{CH}_3\text{OH} & \quad \text{Br}_2 & \quad \text{KMnO}_4 & \quad \text{H}_2\text{SO}_4 & \quad \text{CO}_2
\end{align*}
\]

Select the appropriate starting materials and write equations to show the synthesis of each of the compounds indicated below. (You can use products from syntheses in early parts of the question as raw materials for syntheses in later parts of the question.)

a. \( \text{C}_2\text{H}_5\text{Br} \)

b. \( \text{C}_2\text{H}_5\text{OH} \)

c. \[
\begin{align*}
\text{H} & \quad \text{H} \\
\text{H} & \quad \text{C} & \quad \text{C} & \quad \text{H} \\
\text{Br} & \quad \text{Br}
\end{align*}
\]

d. \( \text{CH}_3\text{COOH} \)

e. \[
\begin{align*}
\text{H} \\
\text{H} & \quad \text{C} & \quad \text{H} \\
\text{C} & \quad \text{O} & \quad \text{O} & \quad \text{CH}_3
\end{align*}
\]
# Question 5

A group of students measured the pressure and volume of a 3 mole sample of H₂ gas at different temperatures. Their results are shown below.

<table>
<thead>
<tr>
<th>Pressure (atm)</th>
<th>Volume (L)</th>
<th>Temperature (°C)</th>
<th>P x V (atm.L)</th>
<th>Temperature (K)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.81</td>
<td>11.2</td>
<td>–50</td>
<td>53.9</td>
<td>223</td>
</tr>
<tr>
<td>3.96</td>
<td>16.9</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.66</td>
<td>14.1</td>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.25</td>
<td>10.1</td>
<td>100</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**a.** Complete the table above.

**b.** On the graph paper provided on the following page, plot a graph of P x V against T (in Kelvin).

**c.** Calculate the slope (gradient) of the graph.

**d.** **Use the above value of the slope** and the ideal gas equation to calculate a value for the gas constant R.
### Assessment standards from the Chemistry Senior External Syllabus 1998

#### Paper One

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Very High Achievement</th>
<th>High Achievement</th>
<th>Sound Achievement</th>
<th>Limited Achievement</th>
<th>Very Limited Achievement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge of subject matter</td>
<td>A very high ability to recall and apply knowledge of chemistry in simple situations.</td>
<td>A high ability to recall and apply knowledge of chemistry in simple situations.</td>
<td>A satisfactory ability to recall and apply knowledge of chemistry in simple situations.</td>
<td>Limited ability to recall and apply knowledge of chemistry in simple situations.</td>
<td>Very limited ability to recall and apply knowledge of chemistry in simple situations.</td>
</tr>
<tr>
<td>Scientific processes</td>
<td>A very high ability to succeed in simple scientific process tasks — collecting and organising data, processing information, making simple judgments, communicating information in various contexts, devising and designing simple and/or single-step investigations.</td>
<td>A high ability to succeed in simple scientific process tasks — collecting and organising data, processing information, making simple judgments, communicating information in various contexts, devising and designing simple and/or single-step investigations.</td>
<td>A satisfactory ability to succeed in simple scientific process tasks — collecting and organising data, processing information, making simple judgments, communicating information in various contexts, devising and designing simple and/or single-step investigations.</td>
<td>Limited ability to succeed in simple scientific process tasks.</td>
<td>Very limited ability to succeed in simple scientific process tasks.</td>
</tr>
</tbody>
</table>