

Trial Examination 2008

## VCE Chemistry Unit 1

Written Examination

### Question and Answer Booklet

Reading time: 15 minutes

Writing time: 1 hour 30 minutes

Student's Name: \_\_\_\_\_

Teacher's Name: \_\_\_\_\_

#### Structure of Booklet

Section	Number of questions	Number of questions to be answered	Marks	Suggested time (minutes)
A Multiple-choice	20	20	20	25
B Short-answer	7	7	50	65
		Total 70		Total 90

Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers and one scientific calculator.

Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.

#### Materials supplied

Question and answer booklet of 14 pages with a detachable data sheet in the centrefold.

Answer sheet for multiple-choice questions.

#### Instructions

Please ensure that you write **your name** and **your teacher's name** in the space provided on this booklet and in the space provided on the answer sheet for multiple-choice questions.

All written responses must be in English.

#### At the end of the examination

Place the answer sheet for multiple-choice questions inside the front cover of this booklet and hand them in.

**Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic communication devices into the examination room.**

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### Question 7

The relative surface energies of two substances are shown in the table below.

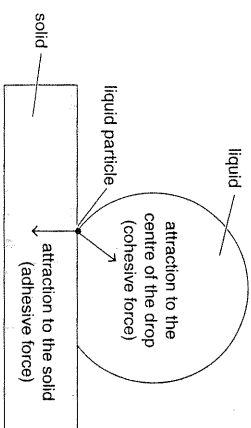
Substance	Relative surface energy
methanol (CH <sub>3</sub> OH)	very low
platinum	high

a. i. What is meant by the term 'surface energy'?

ii. Explain why the surface energy of platinum is high.

1 + 1 = 2 marks

b. The forces acting on a liquid particle in contact with a solid surface determine the extent to which the liquid wets the solid. The diagram below illustrates these forces using the terms 'adhesive force' and 'cohesive force'.



A drop of methanol is placed on the surface of a platinum sheet.

i. Name the bond type responsible for the adhesive forces.

ii. Name the bond type responsible for the cohesive forces.

iii. Will the methanol wet the surface of the platinum? Explain your answer.

1 + 1 + 2 = 4 marks  
Total 6 marks

**END OF QUESTION AND ANSWER BOOKLET**

**SECTION A: MULTIPLE-CHOICE QUESTIONS****Instructions for Section A**

Answer **all** questions in pencil on the answer sheet provided for multiple-choice questions. Choose the response that is **correct** or that **best** answers the question.

A correct answer scores 1, an incorrect answer scores 0. Marks will **not** be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

**Question 1**

Element X is in Group 1 and element Z is in Group 16 of the Periodic Table.

Which of the following represents the most likely compound that elements X and Z would form?

- A. XZ  
 B. XZ<sub>2</sub>  
 C. X<sub>2</sub>Z  
 D. X<sub>2</sub>Z<sub>3</sub>

**Question 2**

The equation below shows the conversion of ethanol to ethanoic acid.



In a balanced equation, the values for coefficients  $n$ ,  $w$ ,  $x$  and  $y$ , respectively, are

- A. 1, 1, 1, 1  
 B. 1, 2, 1, 1  
 C. 1, 2, 1, 2  
 D. 2, 1, 2, 1

**Question 3**

Organic molecules containing the hydroxyl (OH) group are named systematically using the suffix '-ol'.

Which of the following semi-structural formulas represents 3-methyl-2-hexanol?

- A.  $\begin{array}{c} \text{CH}_3\text{CHCH}_2\text{CHCH}_3 \\ | \quad | \\ \text{OH} \quad \text{CH}_2\text{CH}_3 \end{array}$       B.  $\begin{array}{c} \text{CH}_3\text{CH}_2\text{CHCHCH}_3 \\ | \quad | \\ \text{HO} \quad \text{CH}_2\text{CH}_3 \end{array}$   
 C.  $\begin{array}{c} \text{CH}_3\text{CHCHCH}_2\text{CH}_2\text{CH}_3 \\ | \quad | \\ \text{HO} \quad \text{CH}_3 \end{array}$       D.  $\begin{array}{c} \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CHCH}_2 \\ | \quad | \\ \text{HO} \quad \text{CH}_3 \end{array}$

**Question 4**

The two atoms represented by the symbols  $^{25}_{12}\text{Mg}$  and  $^{25}_{13}\text{Al}$  differ in the number of

- A. neutrons only.  
 B. protons and neutrons only.  
 C. protons and electrons only.  
 D. protons, neutrons and electrons.

**Question 5**

The ground state electronic configurations of four elements are shown below.

Which electronic configuration represents a metallic element?

- A.  $1s^2 2s^2 2p^6$   
 B.  $1s^2 2s^2 2p^6 3s^1$   
 C.  $1s^2 2s^2 2p^6 3s^2 3p^2$   
 D.  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^1 4s^2 4p^4$

**Question 6**

Which of the following contains the greatest number of oxygen atoms?

- A.  $1.3 \times 10^{24}$  molecules of carbon dioxide gas  
 B.  $4.0 \times 10^{23}$  atoms of oxygen  
 C. 0.25 mole of oxygen gas  
 D. 22 g of liquid water

**Question 7**

Atoms of element Z have high electronegativity, and can bond to two chlorine atoms.

To which group in the Periodic Table does element Z belong?

- A. Group 2  
 B. Group 14  
 C. Group 16  
 D. Group 18

**Question 8**

The empirical formula of a compound is  $\text{C}_2\text{H}_4\text{O}$ , and its relative molecular mass is 88.

Which of the listed molecular formulas could represent this compound?

- I  $\text{CH}_2\text{CH}(\text{OH})$   
 II  $(\text{CH}_3)_2\text{CHCOOH}$   
 III  $\text{CH}_3\text{CH}_2\text{COOCH}_3$   
 IV  $\text{CH}_2(\text{OH})\text{CH}_2\text{CH}_2\text{COOCH}_2\text{CH}_3$   
 A. I only  
 B. IV only  
 C. II and III only  
 D. I, II, III and IV

**Question 9**

Which of the listed properties of elements increase across the period from sodium to chlorine?

- I atomic radius
- II core charge (effective nuclear charge)
- III electronegativity

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

**Question 10**

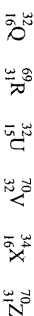
In liquid methanol ( $\text{CH}_3\text{OH}(l)$ ) covalent bonds, hydrogen bonds and dispersion forces are present.

Which of these bonds or forces are broken when a sample of methanol is vapourised?

- A. hydrogen bonds only
- B. hydrogen bonds and dispersion forces only
- C. covalent bonds and hydrogen bonds only
- D. covalent bonds, hydrogen bonds and dispersion forces

**Question 11**

The symbols Q to Z below represent some elements from the Periodic Table. The letter symbols are not the usual symbols for the elements.



Which two symbols represent isotopes of a non-metallic element?

- A. Q and U
- B. Q and X
- C. V and Z
- D. R and Z

**Question 12**

Consider the sequence of molecules  $\text{C}_2\text{H}_2$ ,  $\text{C}_2\text{H}_4$  and  $\text{C}_2\text{H}_6$ .

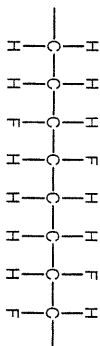
Which of the following increases for the bonding between carbon atoms in this sequence of molecules?

- I polarity
- II length
- III strength

- A. II only
- B. III only
- C. I and II only
- D. I and III only

**Question 13**

The diagram below represents a segment of a copolymer.



The two monomers used to form this polymer are

- A.  $\text{CH}_2\text{FCH}_2\text{F}$  and  $\text{CH}_3\text{CH}_3$
- B.  $\text{CH}_2\text{CF}_2$  and  $\text{CH}_2\text{CH}_2$
- C.  $\text{CHFCHF}$  and  $\text{CF}_2\text{CF}_2$
- D.  $\text{CHFCHF}$  and  $\text{CH}_2\text{CH}_2$

**Question 14**

The table below lists information about three species: X, Y and Z (the symbols X, Y and Z are not the correct symbols for the elements).

	Number of protons	Number of neutrons	Number of electrons
X	53	74	54
Y	55	72	54
Z	53	72	53

Which of the following statements about species X, Y and Z is **incorrect**?

- A. X and Z represent the same element.
- B. X is a negatively charged ion.
- C. X and Z are isotopes.
- D. Y and Z have the same mass number.

**Question 15**

Which of the following ions would undergo the greatest deflection in a mass spectrometer?

- A.  ${}^{14}\text{N}^+$
- B.  ${}^{14}\text{N}^{2+}$
- C.  ${}^{15}\text{N}^+$
- D.  ${}^{15}\text{N}^{2+}$

**Question 16**

When comparing the molecules  $\text{Cl}_2$  and  $\text{HCl}$ , it is correct to say that

- A. both molecules contain a polar bond.
- B. neither molecule contains a polar bond.
- C. both molecules are polar.
- D. one of the molecules is non-polar.

**Question 17**

The attractive forces present in metallic bonding are best described as attraction between

- cations and electrons.
- nuclei and electrons.
- cations and anions.
- anions and electrons.

**Question 18**

For which of the following elements is the Periodic Table group number and period number the same?

- Li
- Mg
- Al
- Be

**Question 19**

Which of the following properties increases with increasing atomic number for both Group 14 and Group 17 elements?

- melting point
- atomic radius
- electrical conductivity
- electronegativity

**Question 20**

Which of the following is least likely to be a subject of nanotechnology investigation?

- a mitochondrion, which has a length of  $0.5 \mu\text{m}$  ( $1 \mu\text{m} = 10^{-6} \text{ m}$ )
- a buckyball, which has a diameter of  $10 \text{ \AA}$  ( $1 \text{ \AA} = 10^{-10} \text{ m}$ )
- a virus, which has a length of  $3 \times 10^{-8} \text{ m}$
- DNA, which has a width of  $2 \text{ nm}$

**SECTION B: SHORT-ANSWER QUESTIONS****Instructions for Section B**

Answer all questions in the spaces provided.

To obtain full marks for your responses you should

- give simplified answers with an appropriate number of significant figures to all numerical questions; unsimplified answers will not be given full marks.
- show all working in your answers to numerical questions. No credit will be given for an incorrect answer unless it is accompanied by details of the working.
- make sure chemical equations are balanced and that the formulas for individual substances include an indication of state; for example  $\text{H}_2(\text{g})$ ;  $\text{NaCl}(\text{s})$ .

**Question 1**

A sample of antimony (Sb) (a Group 15 element) was found to contain two isotopes (Sb-121 and Sb-123) with masses 120.9 and 122.9. The percentage abundances of these isotopes were found to be 32.7 and 67.3 respectively.

- Using the above data to provide examples, explain the meaning of the term
  - 'relative isotopic mass'

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- 'mass number'.

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- Determine the relative atomic mass of antimony based on the data provided.

2 + 2 = 4 marks

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- Was the sample of antimony taken from a naturally occurring deposit? Explain your choice.

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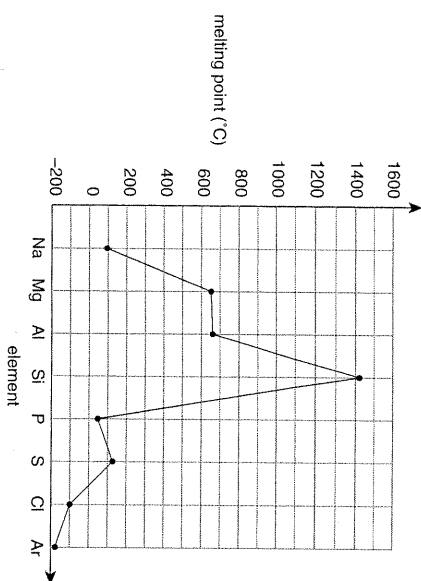
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2 + 1 = 3 marks  
Total 7 marks

**Question 2**

- a. The graph below shows the melting points of the elements Na to Ar.



- By referring to the structure and bonding of the elements, briefly explain why
- aluminium has a higher melting point than sodium.

- Argon has a lower melting point than chlorine.

2 + 2 = 4 marks

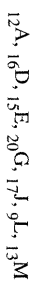
- b. The table below shows the atomic radii for the elements Li to F.

Element	Li	Be	B	C	N	O	F
Atomic radius ( $\times 10^{-12}$ m)	152	106	88	77	70	66	64

Explain the trend in atomic radii of these elements.

2 marks

- c. The symbols A to M below represent some elements from the Periodic Table. The letter symbols are not the usual symbols for the elements. Use these letters when answering the questions which follow.



From the list given above identify the element that

- has a ground state outer shell configuration of  $2s^2 2p^5$ .
- is the most reactive metal.
- reacts with three bromide ions to form a compound.

1 + 1 + 1 = 3 marks  
Total 9 marks

## Question 3

- a. i. Complete the table below by drawing structural diagrams for each of the molecules (showing all bonding and non-bonding electron pairs and the overall shape of the molecules) and naming the shape of each molecule.

Molecule	Structural diagram	Name of shape
$\text{SiCl}_4$		
$\text{SCl}_2$		

- ii. Give the formula for another molecule with the same shape as  $\text{SCl}_2$ .

4 + 1 = 5 marks

- b. In terms of structure and bonding, explain why solid calcium oxide does not conduct electricity, but molten calcium oxide is a good conductor. Include a diagram in your answer.

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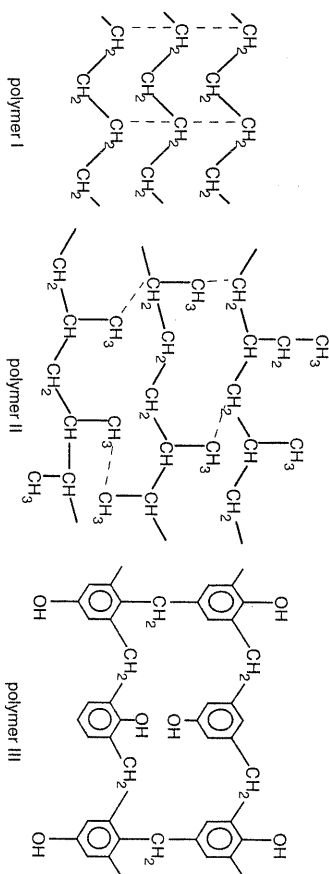


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3 marks  
Total 8 marks

## Question 4

- a. The diagrams below represent sections of three polymers.



- i. Draw the structural formula of the monomer used to generate polymer I.

- ii. Which polymer I or II, would you expect to have the higher melting point? Explain your choice. (Assume that the molar masses of polymers I and II are similar.)

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- iii. Properties x to z can be used to describe features of certain substances.

- x conducts electricity in the solid state
- y melts when heated
- z chars when heated, but does not melt

In the table below, circle the letter or letters (x to z) that apply to each of the polymers.

polymer I	x	y	z
polymer II	x	y	z
polymer III	x	y	z

1 + 2 + 3 = 6 marks

- b. i. State and explain the trend in the boiling points of the first six members of the alkane homologous series.

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- ii. Other homologous series show the trend in boiling point described in part i. State **two** other characteristics of homologous series.

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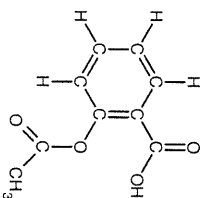
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2 + 2 = 4 marks  
Total 10 marks

### Question 5

- a. Aspirin was the first non-steroidal anti-inflammatory drug used commercially. Its active ingredient is acetylsalicylic acid, a compound with a molar mass of  $180 \text{ g mol}^{-1}$ . One analgesic (pain relieving) tablet normally contains 300 mg of acetylsalicylic acid. The structure of acetylsalicylic acid is shown below.



- i. Write the empirical formula for acetylsalicylic acid.

- ii. Determine the mass (in g) of one molecule of acetylsalicylic acid.

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- iii. Calculate the amount (in mol) of acetylsalicylic acid in one analgesic tablet.

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- iv. Determine the number of atoms of carbon in one analgesic tablet.

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1 + 1 + 1 + 1 = 4 marks

- b. A 2.00 g sample of an organic compound was found to contain  $0.800 \text{ g carbon}$ ,  $8.03 \times 10^{22}$  hydrogen atoms and  $0.0666 \text{ mol of oxygen}$ . Determine the empirical formula of the compound.

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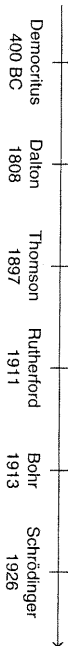
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3 marks  
Total 7 marks

### Question 6

The timeline below shows some of the scientists who have played a role in the development of our understanding of atomic theory.



- a. Draw a labelled diagram of Thomson's model of the atom.

- b. Thomson's and Rutherford's models of the atom, although quite different, shared some common features. State **one** feature common to Thomson's and Rutherford's models of the atom.

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- c. State **one** way in which the current model of the atom differs from that of Bohr's.

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1 mark  
Total 3 marks

## 1. Periodic Table of the elements

<b>1</b> H 1.0 hydrogen																	<b>2</b> He 4.0 helium
<b>3</b> Li 6.9 lithium	<b>4</b> Be 9.0 beryllium	atomic number <b>79</b> Au      symbol of element 197.0      name of element															
<b>11</b> Na 23.0 sodium	<b>12</b> Mg 24.3 magnesium	<b>5</b> B 10.8 boron	<b>6</b> C 12.0 carbon	<b>7</b> N 14.0 nitrogen	<b>8</b> O 16.0 oxygen	<b>9</b> F 19.0 fluorine	<b>10</b> Ne 20.2 neon	<b>13</b> Al 27.0 aluminium	<b>14</b> Si 28.1 silicon	<b>15</b> P 31.0 phosphorus	<b>16</b> S 32.1 sulphur	<b>17</b> Cl 35.5 chlorine	<b>18</b> Ar 39.9 argon				
<b>19</b> K 39.1 potassium	<b>20</b> Ca 40.1 calcium	<b>21</b> Sc 44.9 scandium	<b>22</b> Ti 47.9 titanium	<b>23</b> V 50.9 vanadium	<b>24</b> Cr 52.0 chromium	<b>25</b> Mn 54.9 manganese	<b>26</b> Fe 55.8 iron	<b>27</b> Co 58.9 cobalt	<b>28</b> Ni 58.7 nickel	<b>29</b> Cu 63.5 copper	<b>30</b> Zn 65.4 zinc	<b>31</b> Ga 69.7 gallium	<b>32</b> Ge 72.6 germanium	<b>33</b> As 74.9 arsenic	<b>34</b> Se 79.0 selenium	<b>35</b> Br 79.9 bromine	<b>36</b> Kr 83.8 krypton
<b>37</b> Rb 85.5 rubidium	<b>38</b> Sr 87.6 strontium	<b>39</b> Y 88.9 yttrium	<b>40</b> Zr 91.2 zirconium	<b>41</b> Nb 92.9 niobium	<b>42</b> Mo 95.9 molybdenum	<b>43</b> Tc 98.1 technetium	<b>44</b> Ru 101.1 ruthenium	<b>45</b> Rh 102.9 rhodium	<b>46</b> Pd 106.4 palladium	<b>47</b> Ag 107.9 silver	<b>48</b> Cd 112.4 cadmium	<b>49</b> In 114.8 indium	<b>50</b> Sn 118.7 tin	<b>51</b> Sb 121.8 antimony	<b>52</b> Te 127.6 tellurium	<b>53</b> I 126.9 iodine	<b>54</b> Xe 131.3 xenon
<b>55</b> Cs 132.9 caesium	<b>56</b> Ba 137.3 barium	<b>57</b> La 138.9 lanthanum	<b>72</b> Hf 178.5 hafnium	<b>73</b> Ta 180.9 tantalum	<b>74</b> W 183.8 tungsten	<b>75</b> Re 186.2 rhenium	<b>76</b> Os 190.2 osmium	<b>77</b> Ir 192.2 iridium	<b>78</b> Pt 195.1 platinum	<b>79</b> Au 197.0 gold	<b>80</b> Hg 200.6 mercury	<b>81</b> Tl 204.4 thallium	<b>82</b> Pb 207.2 lead	<b>83</b> Bi 209.0 bismuth	<b>84</b> Po (209) polonium	<b>85</b> At (210) astatine	<b>86</b> Rn (222) radon
<b>87</b> Fr (223) francium	<b>88</b> Ra (226) radium	<b>89</b> Ac (227) actinium	<b>104</b> Rf (261) rutherfordium	<b>105</b> Db (262) dubnium	<b>106</b> Sg (263) seaborgium	<b>107</b> Bh (264) bohrium	<b>108</b> Hs (265) hassium	<b>109</b> Mt (268) meitnerium	<b>110</b> Ds (271) darmstadtium	<b>111</b> Rg (272) roentgenium	<b>112</b> Uub	<b>114</b> Uuq	<b>116</b> Uuh	<b>118</b> Uuo			

<b>58</b> Ce 140.1 cerium	<b>59</b> Pr 140.9 praseodymium	<b>60</b> Nd 144.2 neodymium	<b>61</b> Pm (145) promethium	<b>62</b> Sm 150.3 samarium	<b>63</b> Eu 152.0 europium	<b>64</b> Gd 157.2 gadolinium	<b>65</b> Tb 158.9 terbium	<b>66</b> Dy 162.5 dysprosium	<b>67</b> Ho 164.9 holmium	<b>68</b> Er 167.3 erbium	<b>69</b> Tm 168.9 thulium	<b>70</b> Yb 173.0 ytterbium	<b>71</b> Lu 175.0 lutetium
<b>90</b> Th 232.0 thorium	<b>91</b> Pa 231.0 protactinium	<b>92</b> U 238.0 uranium	<b>93</b> Np 237.1 neptunium	<b>94</b> Pu (244) plutonium	<b>95</b> Am (243) americium	<b>96</b> Cm (251) curium	<b>97</b> Bk (247) berkelium	<b>98</b> Cf (251) californium	<b>99</b> Es (252) einsteinium	<b>100</b> Fm (257) fermium	<b>101</b> Md (258) mendelevium	<b>102</b> No (259) nobelium	<b>103</b> Lr (260) lawrencium

## 2. Physical constants

Avogadro's constant ( $N_A$ ) =  $6.02 \times 10^{23} \text{ mol}^{-1}$ Charge on one electron =  $-1.60 \times 10^{-19} \text{ C}$ Faraday constant ( $F$ ) =  $96\,500 \text{ C mol}^{-1}$ Gas constant ( $R$ ) =  $8.31 \text{ J K}^{-1} \text{ mol}^{-1}$ Ionic product for water ( $K_w$ ) =  $1.00 \times 10^{-14} \text{ mol}^2 \text{ L}^{-2}$  at 298 K (self ionisation constant)Molar volume ( $V_m$ ) of an ideal gas at 273 K, 101.3 kPa (STP) =  $22.4 \text{ L mol}^{-1}$ Molar volume ( $V_m$ ) of an ideal gas at 298 K, 101.3 kPa (SLC) =  $24.5 \text{ L mol}^{-1}$ Specific heat capacity ( $c$ ) of water =  $4.18 \text{ J g}^{-1} \text{ K}^{-1}$ Density ( $d$ ) of water at 25°C =  $1.00 \text{ g mL}^{-1}$ 1 atm =  $101.3 \text{ kPa} = 760 \text{ mmHg}$ 0°C =  $273 \text{ K}$ 

## 3. SI prefixes, their symbols and values

SI prefix	Symbol	Value
giga	G	$10^9$
mega	M	$10^6$
kilo	k	$10^3$
deci	d	$10^{-1}$
centi	c	$10^{-2}$
milli	m	$10^{-3}$
micro	$\mu$	$10^{-6}$
nano	n	$10^{-9}$
pico	p	$10^{-12}$

END OF DATA SHEET