Government of **Western Australia**
School Curriculum and Standards Authority

WACE
Western Australian Certificate of Education

CHEMISTRY

Stage 2

WACE Examination 2012

Marking Key

Marking keys are an explicit statement about what the examiner expects of candidates when they respond to a question. They are essential to fair assessment because their proper construction underpins reliability and validity.

When examiners design an examination, they develop provisional marking keys that can be reviewed at a marking key ratification meeting and modified as necessary in the light of candidate responses.

Section One: Multiple-choice **25% (25 Marks)**

1.	D
2.	A
3.	A
4.	B
5.	C
6.	B
7.	D
8.	A
9.	C
10.	C
11.	A
12.	C
13.	B
14.	C
15.	A
16.	C
17.	D
18.	D
19.	B
20.	B
21.	D
22.	C
23.	D
24.	D
25.	A

End of Section One

Section Two: Short answer **40% (105 Marks)**

Suggested working time: 70 minutes.

Question 26 **(8 marks)**

(a) Chemists use letters and numbers to provide information about chemical species. Even their positions provide information. In each case below, state what information is indicated by the figure within the circle. (3 marks)

Description	Marks
The mass number (is 40) or there is a combined total of 40 neutrons and protons	1
Atomic number (is 19) or there are 19 protons in each atom	1
The atom/ion carries a positive one charge or there is one less electron than protons	1
Total	**3**

(b) Complete the table below for the ion $^{40}_{19}K^{+}$. (4 marks)

Description				Marks
1 mark each				1–4
Number of protons	Number of Neutrons	Number of Electrons	Electron Configuration	
19	21	18	2, 8, 8	
			Total	**4**

(c) Name the element whose atomic form has the same electron configuration as $^{40}_{19}K^{+}$. (1 mark)

Description	Marks
Argon (accept Ar)	1
Total	**1**

Question 27 **(6 marks)**

(a) Complete the table below by writing the formula of each of the compounds listed. (3 marks)

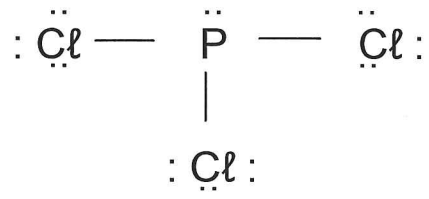
Description	Marks
1 mark for each correct answer:	1–3
Ammonia: NH_3	
sodium oxide: Na_2O	
tin(II) phosphate: $Sn_3(PO_4)_2$	
Total	**3**

(b) Complete the table below by writing the name of each of the compounds listed. (3 marks)

Description	Marks
1 mark for each correct answer:	1–3
$Fe_2(SO_4)_3$: iron(III) sulfate	
P_2S_5: diphosphorus pentasulfide	
C_2H_4: ethene	
Total	**3**

Question 28 **(4 marks)**

For the species listed in the table below, draw electron dot diagrams.

Species	Electron Dot Diagram
$CaC\ell_2$	
$PC\ell_3$	

Description	Marks
Max. 2 marks each	1–4
If non-bonding electrons are not shown in one **or** both answers, award maximum 3 out of 4.	
Total	**4**

Question 29 **(12 marks)**

(a) When solid potassium carbonate is dropped into a container of dilute sulfuric acid, it reacts and bubbles of a colourless gas are given off.

Write the balanced chemical equation for this reaction. Show only those species that take part in the reaction and use the appropriate state symbols. (3 marks)

$$K_2CO_3(s) + 2\,H^+(aq) \rightarrow 2\,K^+(aq) + CO_2(g) + H_2O(\ell)$$

Description	Marks
Correct formulas	1
Correct balancing	1
Correct state symbols	1
Total	**3**

(b) When 4.22 g of solid zinc metal is mixed with excess hydrochloric acid, a gas is produced according to the following equation.

$$Zn(s) + 2\,H^+(aq) \longrightarrow Zn^{2+}(aq) + H_2(g)$$

(i) How many moles of hydrogen gas will be produced? (3 marks)

Description	Marks
$m_{(Zn)} = 4.22g \quad M_{(Zn)} = 65.38\ g\ mol^{-1}$ $n_{(Zn)} = 4.22g / 65.38 = 0.064546\ mol$	1
$n_{(H2)} = n_{(Zn)}$	1
$n_{(H2)} = 0.0645\ mol = 6.45 \times 10^{-2}\ mol$	1
Total	**3**

(ii) What volume will this hydrogen gas occupy at S.T.P.? (2 marks)

Description	Marks
$V_{(H2)} = n \times 22.71$	1
$V_{(H2)} = 1.46\ L$	1
Total	**2**

(c) If the same mass of magnesium instead of zinc was reacted with the hydrochloric acid, would more, less or the same amount of gas be produced under the same conditions?
(4 marks)

Circle your answer (more) less the same

Explain by reason or calculation why this is so.

Description	Marks
More	1
Equation: $Mg(s) + 2\,H^+(aq) \rightarrow Mg^{2+}(aq) + H_2(g)$ Or A statement that same ratio exists of H_2 to Mg as H_2 to Zn	1
Reason: Because the M_{Mg} (24.31 g mol^{-1}) < M_{Zn} (65.38 g mol^{-1}) the same mass of magnesium contains more moles than that of zinc therefore more hydrogen gas will be evolved.	1-2
Or Calculation: n H_2 = nMg = 4.22/24.31 = 0.1736 mol V_{H2} = 0.1736 × 22.71 = 3.94 L This is greater than the 1.46 L produced by the reaction with Zn	
Total	**4**

Question 30 **(9 marks)**

A 29.95 g sample of the hydrated copper(II) sulfate was heated in a crucible over a Bunsen burner to drive off the water from its crystal lattice. The sample was subjected to repeated heating and weighing until there was no further change in mass as indicated by the table below.

Initial sample	1st weighing	2nd weighing	3rd weighing	4th weighing	5th weighing	6th weighing
29.95 g	24.33 g	22.46 g	19.72 g	19.15 g	19.15 g	19.15 g

(a) What was the mass of water driven off from the hydrated form of copper (II) sulfate?
(1 mark)

Description	Marks
29.95 – 19.15 = 10.80 g	1
Total	**1**

(b) Calculate the percentage by mass of copper(II) sulfate in hydrated copper(II) sulfate.
(2 marks)

Description	Marks
% $(CuSO_4) = \frac{19.15}{29.95} \times 100$	1
% $(CuSO_4)$ = 63.9%	1
Total	**2**

(c) Using your answers from Parts (a) and (b), show that the formula of hydrated copper(II) sulfate is $CuSO_4.5H_2O$. (5 marks)

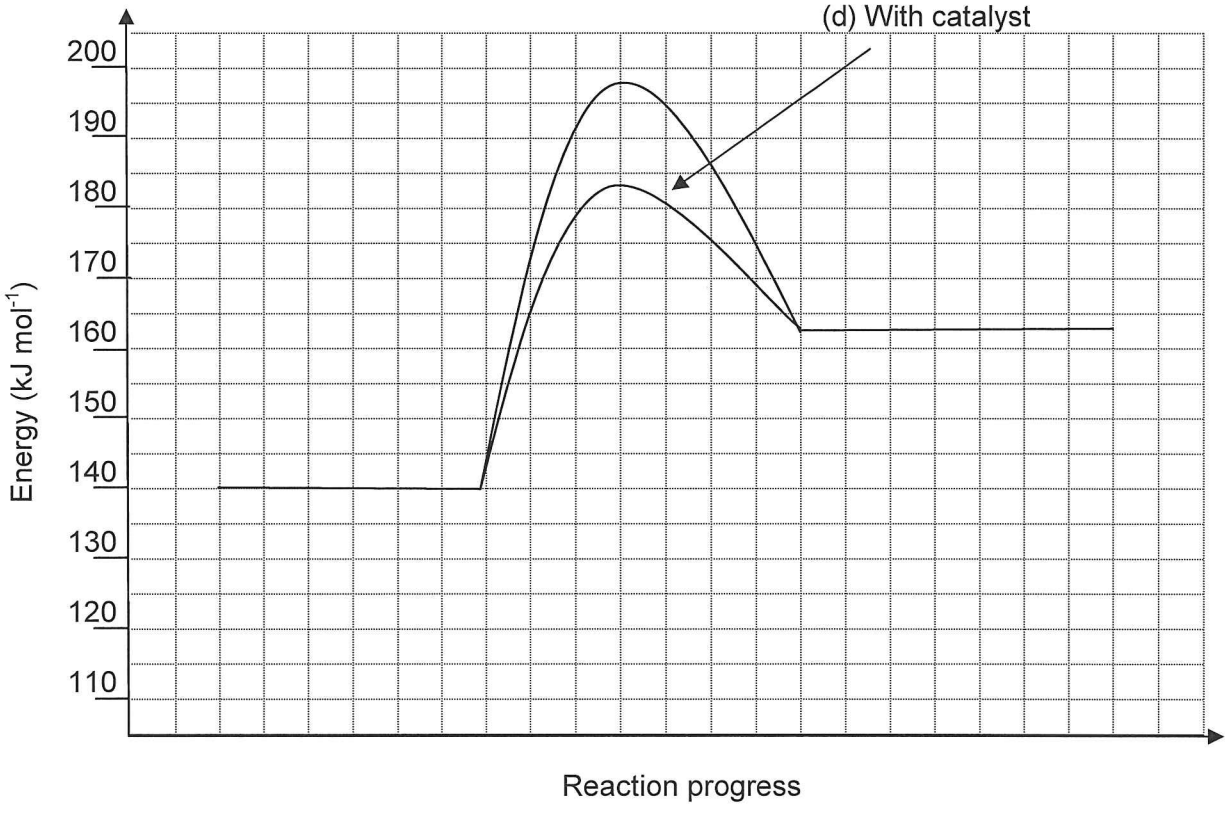
Description	Marks
M ($CuSO_4$) = (63.55) + (32.06) + (4 ×16.0) = 159.61 g mol^{-1}	1
M (H_2O) = (2 × 1.008) + (16.00) = 18.016 g mol^{-1}	1
n ($CuSO_4$) = 19.15 / 159.61 = 0.11998 ~ 0.12	1
n (H_2O) = 10.8 / 18.016 = 0.4801 ~ 0.5995	1
Ratio of $CuSO_4$ to H_2O was 1 : 5 Formula of hydrated copper sulfate was $CuSO_4.5H_2O$	1
Total	**5**

(d) Why was the sample re-heated and re-weighed several times? (1 mark)

Description	Marks
To ensure that all the water within the crystal lattice had been driven off.	1
Total	**1**

Question 31 **(11 marks)**

The energy profile diagram for a particular chemical reaction is given below. Use it to answer the following questions. Use the appropriate units if relevant.



(a) Complete the table with the symbol, value and unit for the chemical reaction's heat of reaction and activation energy. (4 marks)

	Symbol	Value	Unit
Activation energy	E_a	**198 – 140 = 58**	kJ mol^{-1}
Heat of reaction	**ΔH**	**163 – 140 = 23**	**kJ mol^{-1}**

Description	Marks
Activation energy symbol (E_a)	1
Activation energy value 58 ± 2 (accept 56 to 60)	1
Heat of reaction value 23 ± 2 (accept 21 – 25)	1
Units for both (kJ mol^{-1})	1
Total	**4**

(b) On the energy profile diagram above, sketch what the graph would look like if a catalyst was used. (2 marks)

Description	Marks
Lower E_a	1
Correct shape with same enthalpies of reactants and products	1
Total	**2**

(c) By circling the correct answer below, indicate whether the reaction represented in the energy profile diagram is exothermic, endothermic or neither. (1 mark)

exothermic (endothermic) neither

Description	Marks
endothermic	1
Total	**1**

(d) By circling the correct answer below, indicate the change in temperature that would be observed if a thermometer was placed into the reaction vessel during the reaction. (1 mark)

increase (decrease) no change

Description	Marks
decrease	1
Total	**1**

e) By circling the correct answer below, indicate whether the energy stored in the bonds of the reactants of an **exothermic** reaction has a higher, lower or equivalent value than that of the energy stored in the bonds of the products. (1 mark)

higher lower equivalent

Description	Marks
higher	1
Total	**1**

(f) It is not possible to observe a chemical reaction on an atomic level but macroscopic changes can be observed and measured. In general terms, what change could be measured to determine if a substance added to a reaction actually increased the rate of the chemical reaction? (2 marks)

Description	Marks
The time taken for:	1
- the products to form or - reactants to be consumed or - the reaction to reach completion or - an equivalent point reached in the reaction	1
Total	**2**

Question 32 **(9 marks)**

(a) For each of these two substances, state the type of bonding, a use and the property of each substance that allows it to be used as suggested. (6 marks)

Substance	Type of bonding	Use	Property
graphite	Covalent network	• 'Lead' pencils • Dry lubricant • High temperature moulds and crucibles • Electrodes • Fire retardant	• Soft • Weakly held layers that slide over each other • Chemically resistant • High melting point • Good conductor of heat • Good conductor of electricity
copper	Metallic	• Gas pipes • Water pipes • Electrical wires • Electronic circuit boards • Making alloys (brass & bronze) • Coins • Art • Heat sinks • Water drains • Cookware	• Malleable • Ductile • High lustre when polished • Very good conductor of heat • Very good conductor of electricity • Resistant to corrosion

Description		Marks
Graphite	Covalent network bonding	1
	A use (see above for examples)	1
	A property that is clearly linked to the use stated (see above)	1
Copper	Metallic bonding	1
	A use (see above for examples)	1
	A property that is clearly linked to the use stated (see above)	1
	Total	**6**

(b) Describe how the theory of bonding in copper can explain the property stated in Part (a). (3 marks)

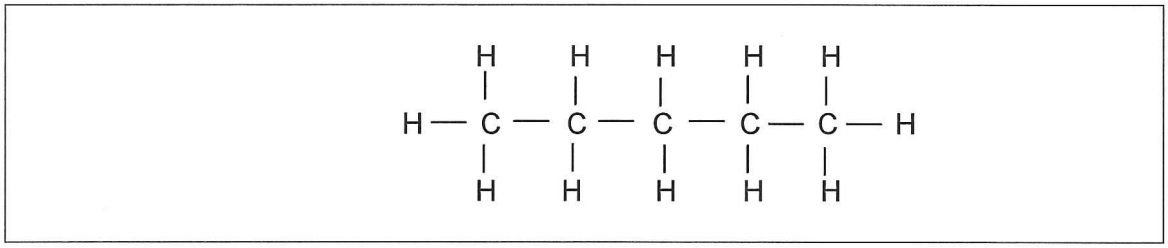
Description	Marks
One property previously mentioned	1–3
Clear relevant explanation of copper's bonding that gives rise to the property stated, and explain the link	
Total	**3**

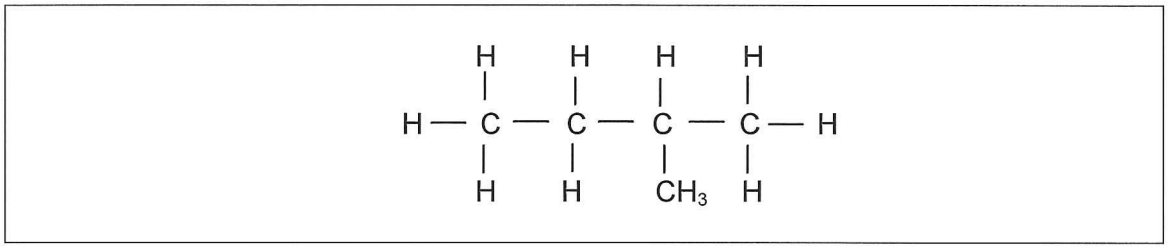
Question 33 **(11 marks)**

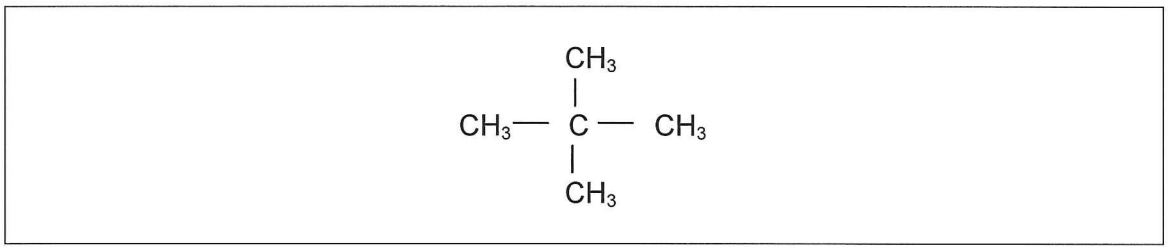
(a) Carbon can form many different compounds. State two aspects of carbon's bonding capacity that explain this phenomenon. (2 marks)

Description	Marks
Any two reasons, 1 mark for each • Can make strong bonds with itself • Can make single, double and triple bonds • Can bond with up to four other atoms simultaneously	1–2
Total	**2**

(b) Draw three structural isomers of pentane, C_5H_{12}. (3 marks)





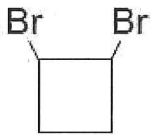


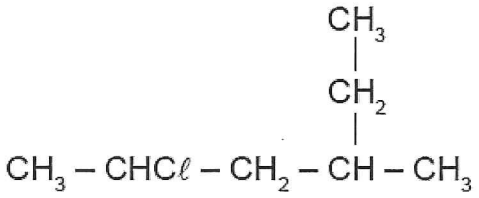
Description	Marks
Correct structures, 1 mark each	1–3
Total	**3**

(c) State the IUPAC name for each of the following organic compounds. (4 marks)

$CH_3 - CH_2 - CH_2 - CH_2 - CH_2 - CH_2 - CH = CH_2$

$CH_3 - CH_2 - CHI - CH_2 - CH_3$





Description	Marks
oct-1-ene	1
3-iodopentane	1
1,2-dibromocyclobutane	1
2-chloro-4-methylhexane	1
Total	**4**

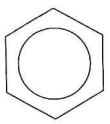
(d) Write the balanced equation for the combustion of benzene in excess oxygen gas. (2 marks)

$2\ C_6H_6(\ell) + 15\ O_2(g) \rightarrow 12\ CO_2(g) + 6\ H_2O(g)$

or

$C_6H_6(\ell) + 15/2\ O_2(g) \rightarrow 6\ CO_2(g) + 3\ H_2O(g)$

or


(ℓ) + $15/2\ O_2(g) \rightarrow 6\ CO_2(g) + 3\ H_2O(g)$

NB: (7½ is acceptable in place of 15/2)

Description	Marks
Correct formulae	1
Correctly balanced	1
Total	**2**

NOTE: that state symbols are not required for full marks.

Question 34 **(10 marks)**

(a) Write the balanced chemical equation for the reaction, if any, that occurs when each of the following substances are mixed as described. Only include those species that take part in the reaction. If no reaction occurs write, 'no reaction'.

(4 marks)

(i) Iron(III) sulfate solution is mixed with sodium carbonate solution.

$$2Fe^{3+}(aq) + 3CO_3^{2-}(aq) \rightarrow Fe_2(CO_3)_3(s)$$

Description	Marks
Correct formulae (no mark if molecular formula or spectator ions included)	1
Correctly balanced (mark given if molecular formula or spectator ions are included but are correctly balanced)	1
Total	**2**

(ii) Ammonia gas is bubbled through a dilute solution of nitric acid.

$$NH_3(g) + H^+(aq) \rightarrow NH_4^+(aq)$$

or

$$NH_3(g) + H_3O^+(aq) \rightarrow NH_4^+(aq) + H_2O(\ell)$$

Description	Marks
Correct formulae (no mark if molecular formula or spectator ions included)	1
Correctly balanced (mark given if molecular formula or spectator ions are included but are correctly balanced)	1
Total	**2**

NOTE: that state symbols are not required for full marks in (i) and (ii).

(b) Describe the predicted observations for the reactions, if any, when each of the following substances is mixed as described. If no reaction occurs write, 'no observable change'.

(6 marks)

Bromine water, $Br_2(aq)$, is added to potassium iodide solution, KI(aq).

Silver nitrate $AgNO_3$ (aq), is added to sodium sulfide solution, $Na_2S(aq)$.

Magnesium ribbon Mg(s) is ignited and placed in a gas jar full of oxygen gas $O_2(g)$.

Description	Marks
Yellow & colourless solutions mix to form orange (accept pink) liquid and a brown (accept purple / black) precipitate	1–2
Two colourless solutions mix to form a black solid / precipitate	1–2
Silvery grey solid burns with a bright white light, producing a white ash	1–2
Total	**6**

Question 35 **(3 marks)**

Given a 0.0111 mol L^{-1} $Mg(NO_3)_2$ solution, calculate the concentration in g L^{-1} for each ion present.

Description	Marks
n (Mg^{2+}(aq)) = n $Mg((NO_3)_2$(aq)) & n (NO_3^-(aq)) = 2 × n ($Mg(NO_3)_2$(aq))	1
c (Mg^{2+}(aq)) = 0.0111 × 24.31 = 0.2698 = 0.270 g L^{-1}	1
c (NO_3^-(aq)) = 2 × 0.0111 mol L^{-1} × 62.01= 0.376662 = 1.38 g L^{-1}	1
Total	**3**

Question 36 **(12 marks)**

(a) Write the structural formula for any products when propane ($CH_3 - CH_2 - CH_3$) is mixed with iodine (I_2) in the presence of UV light and a catalyst.

(2 marks)

$$CH_3 - \underset{\displaystyle I}{\underset{|}{CH}} - CH_3 \quad + \quad HI \quad \text{or} \quad CH_3 - CH_2 - \underset{\displaystyle I}{\underset{|}{CH_2}} \quad + \quad HI$$

Description	Marks
Products identified , 1 mark; and structures correct , 1 mark	1–2
Total	**2**

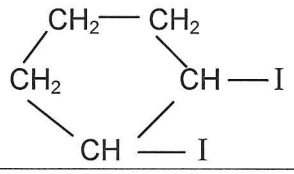
(b) Write the structural formula for any products when propene ($CH_2 = CH - CH_3$) is mixed with iodine (I_2).

(2 marks)

$$\underset{\displaystyle I}{\underset{|}{CH_2}} - \underset{\displaystyle I}{\underset{|}{CH}} - CH_3$$

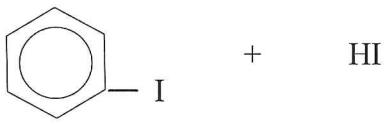
Description	Marks
Products identified , 1 mark; and structures correct , 1 mark	1–2
Total	**2**

(c) Write the structural formula for any products when cyclopentene is mixed with iodine (I_2). (2 marks)



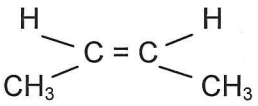
Description	Marks
Products identified , 1 mark; and structures correct , 1 mark	1–2
Total	**2**

(d) Write the structural formula for any products when benzene is mixed with iodine (I_2) in the presence of UV light and a catalyst. (2 marks)

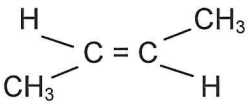


Description	Marks
Products identified , 1 mark; and structures correct , 1 mark	1–2
Total	**2**

(e) Draw and name the geometric isomer of but-2-ene. (4 marks)



Name: *cis*-but-2-ene



Name: *trans*-but-2-ene

Description	Marks
Structure (1 mark) and name (1 mark) for each	1–4
Total	**4**

Question 37 **(10 marks)**

At each step describe the test used, describe the identifying observations and write the name of the substance formula identified by that test.

Test description	Observations	Name of the identified substance
Add 0.1M HCℓ(aq)	Colourless, odourless gas evolved	zinc carbonate
To remaining solutions add 0.1M $AgNO_3$ solution	White precipitate formed	zinc chloride
To remaining solutions add 0.1M $Ba(NO_3)_2$ solution	White precipitate formed	aluminium sulfate
Remaining solution	No reaction with any of previous tests	aluminium nitrate

Description	Marks
Matching test, observation & reagent for each of first three tests, 3 marks each (part marks possible)	1–9
Identification of remaining substance	1
Total	**10**

Question 38 **(11 marks)**

Vinegar is a common household substance that for years has been used in a variety of ways in and around the home.

(a) List three distinctly different uses for vinegar in and around the home. (3 marks)

Description	Marks
Any three of the following, 1 mark each: • Flavour enhancer • food preservative; • pickling; • deodoriser; • glass cleaner; • treat hard water, clean calcium & lime deposits; • balancing pH of lime soils; acidifying soils; • fungicide; weed killer; • clothes stain remover; • fabric softener • removes copper tarnish; • first aid treatment for stings	1–3
Total	**3**

(b) Why might solutions above 10% require careful handling? (2 mark)

Description	Marks
Being an acid, acetic acid is corrosive to skin, eyes etc	1
Increasing concentration increases corrosive nature	1
Total	**2**

(c) Vinegar is characterised as a dilute solution. What does 'dilute' mean in this case? (3 marks)

Description	Marks
Contains few particles of solute (acetic acid) dissolved in a large number of solvent particles (or clear diagram)	1–2
Clarity of expression	1
Total	**3**

(d) Acetic acid is characterised as a weak acid. What does 'weak' mean in this case? (3 marks)

Description	Marks
Only limited proportion of CH_3COOH molecules ionize to form $CH_3COO^-(aq)$ and $H^+(aq)$ ions in solution. Only partially ionizes so remains predominately as CH_3COOH molecules	1
Clarity of expression	1
Equation: $CH_3COOH_{(aq)} \rightleftharpoons CH_3COO^-_{(aq)} + H^+_{(aq)}$	1
Total	**3**

NOTE: that state symbols are not required for full marks.

Question 39 **(12 marks)**

(a) The ingredient in eggshells that makes them hard is calcium carbonate, $CaCO_3(s)$. Write the equation for the reaction that occurs when vinegar ($CH_3COOH(aq)$ and eggshells come in contact with each other. (2 marks)

$CaCO_3(s) + 2\ CH_3COOH(aq) \rightarrow Ca^{2+}(aq) + 2\ CH_3COO^-(aq) + CO_2(g) + H_2O(\ell)$

Description	Marks
Correct formulas	1
Correct balancing	1
Total	**2**

NOTE: that state symbols are not required for full marks.

(b) If each eggshell contains on average 4.00 g of calcium carbonate, what is the maximum number of eggs that can be softened by having all their calcium carbonate dissolved if they are immersed in one 2.00 L bottle of vinegar containing 5.00% acetic acid? Assume that 2.00 L of vinegar has a mass of 2.00 kg. (4 marks)

Description	Marks
m (CH_3COOH) = 5.00/100 × 2.00 kg = 100.0 g M (CH_3COOH) = 60.052 g mol^{-1}	1
n (CH_3COOH) = 100.0 / 60.052 = 1.67 mol	1
n ($CaCO_3$) = 0.5 × n CH_3COOH = 0.8326 mol	1
m ($CaCO_3$) = 0.8326 × 100.09 = 83.33 g	1
No. eggs = 83.33 / 4.00 = 20.8 Maximum number of eggs = 20 eggs (limiting reagent)	1
Total	**5**

(c) The label on a 1.25 L bottle of vinegar states that it contains 25.0 g of acetic acid, $CH_3COOH(aq)$.

(i) Calculate the number of moles of acetic acid present in the full bottle of vinegar. (2 marks)

Description	Marks
m (CH_3COOH) = 25.0 / 60.052	1
= 0.416 mol	1
Total	**2**

(ii) Determine the concentration of acetic acid in mol L^{-1}. (1 mark)

Description	Marks
in mol L^{-1} $c(CH_3COOH)= 0.416 / 1.25 = 0.333$ mol L^{-1}	1
Total	**1**

(iii) Determine the concentration of acetic acid in g L^{-1}. (1 mark)

Description	Marks
in g L^{-1} $c(CH_3COOH)= 25 / 1.25 = 20.0$ g L^{-1}	1
Total	**1**

(iv) 2.0 L of this vinegar will soften fewer eggs than the vinegar in Part (b). Explain why. (1 mark)

Description	Marks
It contains fewer (½ as many) moles of acid	1
Total	**1**

Question 40 **(15 marks)**

(a) Use the kinetic theory of matter to explain what happens to the volume of the gases produced as the temperature of the combustion chamber increases. Include at least one diagram. (3 marks)

Description	Marks
As the temperature increases the average velocity of the gas particles increases and correspondingly so does their average kinetic energy.	1
At constant pressure, the volume of the gas increases with temperature	1
Diagram depicting motion of particles and increasing volume with increased kinetic energy.	1
Total	**3**

(b) By referring to the collision theory explain why the fuel-air mixture is sprayed as a fine mist rather than poured into the combustion chamber for burning. (3 marks)

Description	Marks
According to the collision theory, the rate of a chemical reaction is increased as the rate of collision occurring between the particles of the reacting substances increases.	1
Spraying as a fine mist increases the surface area of reacting substances and hence increases the collisions / contact of the reacting particles.	1
As a consequence the rate of reaction increases.	1
Total	**3**

(c) Other than by experimentation, how could a chemist predict the best fuel to oxygen ratio? (1 mark)

Description	Marks
By writing a balanced chemical equation the stoichiometric ratio of reactants is determined.	1
Total	**1**

The following questions involve determining the identity of a particular fuel. The fuel is a hydrocarbon.

(d) To avoid any changing density problems, masses rather than volumes were used in the first part of the investigation. 1.00 kg of this fuel was burned in excess oxygen. The gases were collected and examined. It was found that 3.10 kg of carbon dioxide and 1.26 kg of water were produced.

Calculate the empirical formula of the fuel that was used. Show all your workings. (5 marks)

Description	Marks
$n(C) = n(CO_2) = m/M = 3.10 \times 10^3 / 44.01 = 70.44$ mol	1
$n(H) = 2 \times n\ H_2O = 2 \times m/M = 2 \times 1.26 \times 10^3 / 18.016 = 139.8$ mol	1 | N(C) : n(H) 70.44 : 139.8 1 : 1.98 1 : 2	1–2
Empirical formula = CH_2	1
Total	**5**

or

Description	Marks
$n(C) = 3.10 \times 10^3 \times (12.01 / 44.01) = 845.97$ g	1
$m(H) = 1.26 \times 10^3 \times (2.016 / 18.016) = 140.99$ g	1 | N(C) : n(H) 845.97/12.01 : 140.99/1.008 70.44 : 139.8 1 : 1.99 1 : 2	1–2
Empirical formula = CH_2	1
Total	**5**

(e) Further investigation occurred and it was found that at 0°C and 100 kPa, 50.0 g of this fuel produced 11.5 L of gas. What is the molecular formula of the fuel that was used? (3 marks)

Description	Marks
n (fuel) = V / 22.71 = 11.5 / 22.71 = 0.5064 mol	1
M (fuel) = m / n = 50.0 / 0.5064 = 98.7 g mol^{-1}	1
Molecular formula = (M / EFM) x Empirical formula = 98.7 / 14.026 × CH_2 = 7 × CH_2 = C_7H_{14}	1
Total	**3**

Question 41 **(12 marks)**

(a) Write the half equation where the silver sulfide, $Ag_2S(s)$, is converted to pure silver, Ag(s). (2 marks)

Description	Marks
$Ag_2S + 2e^- \rightarrow 2Ag + S^{2-}$	
Correct formulas	1
Correct balancing	1
Total	**2**

(b) Write the half equation where aluminium forms aluminium ions. (2 marks)

Description	Marks
$A\ell \rightarrow A\ell^{3+} + 3e^-$	
Correct formulas	1
Correct balancing	1
Total	**2**

(c) Combine the two reaction half-equations to produce a balanced overall redox equation for the process. (2 marks)

Description	Marks
$3Ag_2S_{(s)} + 2A\ell \rightarrow 6Ag + 2A\ell^{3+} + 3S^{2-}$	
Correct formulas	1
Correct balancing	1
Total	**2**

(d) Explain the purpose of the salt and baking soda solution. (1 mark)

Description	Marks
To allow the flow of ions	1
Total	**1**

(e) Circle the substance that is acting as the cathode. (1 mark)

The tarnished silver or the aluminium foil

Description	Marks
The tarnished silver	1
Total	**1**

(f) Circle the substance at which reduction is occurring: (1 mark)

The tarnished silver or the aluminium foil

Description	Marks
The tarnished silver	1
Total	**1**

(g) Circle the arrow showing the correct direction in which electrons will flow during this process. (1 mark)

Description	Marks
←	1
Total	**1**

(h) State the oxidation number of silver: (2 marks)

(i) in the Ag_2S tarnish. **+1**

(ii) when it has been converted to the silver metal. **0**

Description	Marks
(i) +1	1
(ii) 0	1
Total	**2**