Year 11 Unit 1 Examination, 2016

MARKING KEY

CHEMISTRY

Student Name: _____

Time allowed for this paper

Reading time before commencing work: ten minutes
Working time for paper: three hours

Section	Marks
1	/25
2	/70
3	/80
total	/200
	%

Materials required/recommended for this paper

To be provided by the supervisor

This Question/Answer Booklet
Multiple-choice Answer Sheet
Chemistry Data Sheet

To be provided by the candidate

Standard items: pens (blue/black preferred), pencils (including coloured), sharpener, correction tape/fluid, eraser, ruler, highlighters

Special items: up to three non-programmable calculators approved for use in the WACE examinations

Important note to candidates

No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised notes or other items of a non-personal nature in the examination room. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.

Structure of this paper

Section	Number of questions available	Number of questions to be answered	Suggested working time (minutes)	Marks available	Percentage of exam
Section One: Multiple-choice	25	25	50	25	25
Section Two: Short answer	8	8	60	70	35
Section Three: Extended answer	5	5	70	80	40
				Total	100

Section One: Multiple-choice SOLUTIONS

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

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

This section has **25** questions. Answer **all** questions on the separate Multiple-choice Answer Sheet provided. For each question shade the box to indicate your answer. Use only a blue or black pen to shade the boxes. If you make a mistake, place a cross through that square, do not erase or use correction fluid, and shade your new answer. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

Suggested working time: 50 minutes.

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1. Which one of the following is a correct ground state electron configuration for a metallic element in Period 3 of the periodic table?

   (a) 2, 5, 3
   (b) 2, 3
   (c) 2, 8, 2
   (d) 2, 8, 7

2. Which of one of the elements below will have the highest first ionisation energy?

   (a) hydrogen
   (b) chlorine
   (c) sulphur
   (d) lithium

3. Which one of the following statements best explains why atomic radius increases down Group 1 of the periodic table from lithium to francium?

   (a) The first ionisation energies of the elements increases.
   (b) The number of protons in the nucleus of the atoms increases.
   (c) The reactivity of the metals increases.
   (d) The number of energy levels increases.

4. In flame tests, compounds containing different metals produce flames of varying colours. For example, sodium compounds produce a bright orange flame and barium compounds produce a pale green flame.

   Which one of the following statements about flame tests is true?

   (a) The different colours observed for sodium and barium are because they are in different groups of the periodic table.
   (b) Energy in the form of visible light is released from the atoms as electrons drop from a higher to a lower energy level.
   (c) The colours produced are caused by the absorption of light of particular wavelengths.
   (d) Atoms are ionised (electrons are lost from the atoms) in the process that generates the coloured flames.

5. Which one of the following statements about the periodic table is **false**?

   (a) Elements in the periodic table are ordered based on their atomic masses.
   (b) There are eight elements in Period 2 of the periodic table because eight is the maximum number of electrons in the second electron shell/energy level.
   (c) Elements in the same group of the periodic table tend to have similar chemical properties.
   (d) Elements in the same period of the periodic table have the same number of electron shells/energy levels.

6. Which one of the following contains the most atoms of chlorine?

   (a) $CHC\ell_3$
   (b) $2\ NaC\ell$
   (c) $C\ell_2C{=}CI_2$
   (d) $2\ Mg(OC\ell)_2$

7. Which one of the statements below concerning the isotopes carbon-13 and carbon-14 is true?

   (a) carbon-13 can be represented as .
   (b) carbon-14 has more protons than carbon-13.
   (c) carbon-13 and carbon-14 are the only isotopes of carbon.
   (d) carbon-14 has a less stable nucleus than carbon-13.

8. Heavy water is a compound made from hydrogen-2 (deuterium) bonded with oxygen. Its formula can be written as D_2O.

   Which one of the following statements about D_2O would be true?

   (a) It would have the different chemical properties than water.
   (b) The bonding in D_2O would be the same as the bonding in H_2O.
   (c) The boiling point of D_2O and H_2O and would be the same.
   (d) The density of D_2O would be the same as the density of H_2O.

9. Which one of the following is the best definition of a nanomaterial?

   (a) A material that contains particles that have a size of less than 1 nanometre.
   (b) A material that contains particles that are smaller than molecules.
   (c) A material that has different properties to the bulk material because of the small size of the particles that it contains.
   (d) A material that is an allotrope of carbon that has a structure based on covalent networks.

10. Which one of following is the best explanation as to why two different metals will not form a chemical bond?

    (a) Metals cannot be mixed together as they have different densities.
    (b) All metals have low ionisation energies.
    (c) All metals need to lose electrons when they bond to achieve a complete valence electron shell.
    (d) Electrons on the valence shells of adjoining metals repel each other.

11. Which one of the following was the major contribution of Thomson to the development of the understanding of the structure of the atom?

(a) The idea that elements contained just one type of atom.
(b) The discovery of the electron as a negatively charged sub-atomic particle.
(c) The realisation that most of the mass of an atom was present in a relatively small nucleus.
(d) Providing evidence that electrons existed in shells with different energy levels.

12. Which one of the below is the relative atomic mass (atomic weight) of a carbon-12 atom?

(a) 12.00
(b) 1.00
(c) 12.01
(d) 6.00

13. The relative atomic mass (atomic weight) of gold is 197.0. Which of the following statements regarding gold is **false**?

(a) The most common isotope of gold contains 118 neutrons.
(b) Gold must not have any isotopes.
(c) The average atomic masses of the isotopes of gold equals 197.0.
(d) One mole of gold atoms has a mass of 197.0 g.

14. The first process in a mass spectroscopy experiment is the ionisation of the sample. Which of the following statement is true?

(a) This ionisation can be caused by collisions with high energy electrons.
(b) The positive ions that are produced are accelerated using a magnetic field.
(c) Only negative ions are produced in this process.
(d) Once moving through the magnetic field, the heavier ions are deflected more than the lighter ions.

15. A student was testing the effect of adding salt to pure water. Her results are shown below.

Sample	Volume of distilled water (mL)	Mass of salt added (g)	Melting point (°C)	Boiling point (°C)
A	100	0	0	100
B	100	2		

Predict the missing results for Sample C.

	Melting Point (°C)	Boiling Point (°C)
(a)	+2	101
(b)	-2	98
(c)	0	100
(d)	-2	102

16. Carbon dioxide (CO_2) is a defined as a compound because

(a) the carbon and the oxygen are present in a 1:2 ratio.
(b) all molecules are compounds.
(c) the carbon and the oxygen are chemically combined.
(d) It is the only way that carbon and oxygen can combine together.

17. The boiling point of ethanol is 77 °C. A student suggested separating a mixture of water and ethanol using distillation. Which of the statements about the process is true?

(a) Distillation can only be used to separate mixtures that contain two different substances.
(b) The concentration of ethanol in the distillate will be greater than in the original mixture.
(c) When the mixture starts to boil, the vapour produced will initially contain mainly water.
(d) The difference between the boiling points of water and ethanol is too small to allow them to be distilled.

18. Which one of the following will contain 12.06×10^{23} atoms?

(a) 88.02 g of carbon dioxide gas
(b) 4.003 g of helium gas
(c) 16.00 g of oxygen gas
(d) 38.00 g of fluorine gas

19. Which one of the following equations is **not** balanced?

(a) $2\ C_8H_{18} + 25\ O_2 \rightarrow 16\ CO_2 + 18\ H_2O$
(b) $2\ C_8H_{18} + 17\ O_2 \rightarrow 16\ CO + 18\ H_2O$
(c) $C_8H_{16} + 24\ O_2 \rightarrow 8\ CO_2 + 8\ H_2O$
(d) $C_8H_{16} + 8\ O_2 \rightarrow 8\ CO + 8\ H_2O$

20. Which one of the following formulae of aluminium compounds is correct?

(a) $A\ell(NO_3)_2$
(b) $A\ell(PO_4)_3$
(c) $A\ell O_3$
(d) $A\ell N$

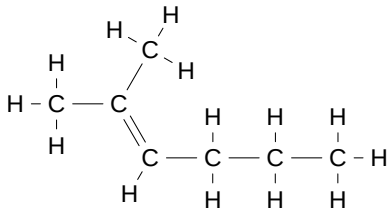
21. Which one of the following will react with chlorine in darkness (without the presence of UV light)?

(a) $(CH_3)_2CHCH_2CH_3$
(b) $(CH_3)_2CCHCH_3$
(c) $CH_3CH_2CH_3$
(d) C_6H_6

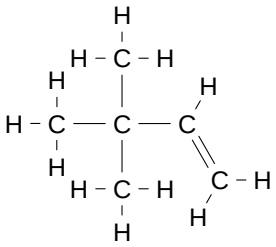
22. Which one of the below is the molecular structural formulae for

2,2-dimethylhex-3-ene?

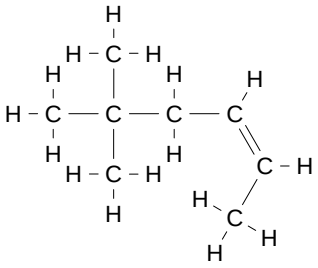
(a)



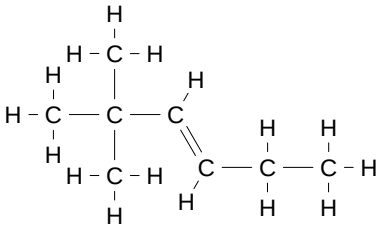
(c)



(b)



(d)



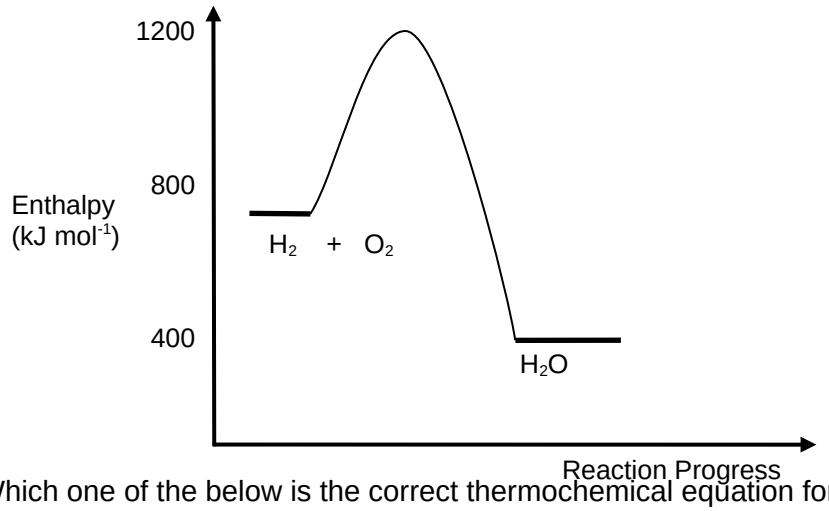
23. Which one of the following best explains why solid magnesium chloride does not conduct an electric current but molten magnesium chloride does conduct electricity?

(a) The magnesium chloride only forms ions in the liquid state.
(b) The electrons in the magnesium are free to move in the molten magnesium chloride.
(c) The ions in the solid form are in fixed positions but when melted they are free to move.
(d) In molten magnesium chloride electrons can move from the magnesium atoms to the chlorine atoms.

24. Which one of the following molecules only contains single covalent bonds?

(a) CO_2
(b) N_2
(c) C_2H_4
(d) NH_3

25. An energy profile diagram for a chemical reaction is shown below.



Which one of the below is the correct thermochemical equation for this reaction?

(a) $2\ H_2(g) + O_2(g) \rightarrow 2\ H_2O(g) + 300\ kJ\ mol^{-1}$

(b) $2\ H_2(g) + O_2(g) + 1200\ kJ\ mol^{-1} \rightarrow 2\ H_2O(g)$

(c) $2\ H_2(g) + O_2(g) + 300\ kJ\ mol^{-1} \rightarrow 2\ H_2O(g)$

(d) $2\ H_2(g) + O_2(g) + 500\ kJ\ mol^{-1} \rightarrow 2\ H_2O(g)$

End of Section One

Section Two: Short answer **35% (70 Marks)**

This section has **8** questions. Answer **all** questions. Write your answers in the spaces provided.

When calculating numerical answers, show your working or reasoning clearly. Express numerical answers to the appropriate number of significant figures and include appropriate units where applicable.

Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.

- Planning: If you use the spare pages for planning, indicate this clearly at the top of the page.
- Continuing an answer: If you need to use the space to continue an answer, indicate in the original answer space where the answer is continued, i.e. give the page number. Fill in the number of the question(s) that you are continuing to answer at the top of the page.

Suggested working time: 60 minutes.

Question 26 **(6 marks)**

(a) State the formula of the following compounds. (3 marks)

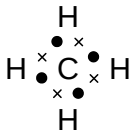
Description	Marks
Na_2O	1
$Fe_2(SO_4)_3$	1
$Mg(HCO_3)_2$	1
Total	**3**

(b) State the names of the following compounds. (3 marks)

Description	Marks
ammonium nitrate	1
ammonia	1
sulfur dioxide	1
Total	**3**

Question 27 **(12 marks)**

(a) Draw an electron dot diagram (Lewis diagram) showing the bonding present in a molecule of methane (CH_4). (1 mark)

Description	Marks
 *can use dots or crosses for electrons*	1
Total	

(b) Explain why the valency of carbon in this molecule is four. (2 marks)

Description	Marks
atom completing its outer/valence shell	1
has four valence electrons / requires four more electrons / shares four pairs	1
Total	**2**

(c) Draw an electron dot diagram showing the bonding present in the ionic compound magnesium hydride. (3 marks)

$[Mg]^{2+}\ 2[H\!:]^{-}$ *or* $[Mg]^{2+}\ [H\!:]^{-}_{2}$

Description	Marks
magnesium ion correct	1
hydride ion correct	1
2 hydride ions	1
Total	**3**

(d) Using your knowledge of structure and bonding, and with the aid of a diagram, explain why methane is a gas at room temperature. (3 marks)

Description	Marks
weak bonds between molecules	1
low amount of energy required to separate molecules	1
labelled diagram	1
Total	**3**

(f) Using your knowledge of structure and bonding explain why magnesium hydride is a solid at room temperature. (3 marks)

Description	Marks
strong ionic bonds	1
throughout the lattice/network	1
high amount of energy required to separate ions	1

Total	**3**

Question 28 **(8 marks)**

For each of the following reactions, write a balanced chemical equation (including state symbols). Using your data sheet if required, predict one observation for each reaction.

(a) Solid iron(III) oxide is added to dilute hydrochloric acid to produce iron(III) chloride, and water. (4 marks)

Equation:

$Fe_2O_3(s)$ + 6 HCl(aq) → 2 $FeCl_3$(aq) + 3 H_2O(l)

Description	Marks
correct formula	1
balanced	1
correct state symbols	1
Total	**3**

Observations:

Description	Marks
any one from: • (pale) brown solid dissolves • (pale) brown solution forms	1
Total	**1**

(b) Copper metal is heated in air to produce copper(II) oxide. (4 marks)

Equation:

2 Cu(s) + O_2(g) → 2 CuO(s)

Description	Marks
correct formula	1
balanced	1
correct state symbols	1
Total	**3**

Observations:

Description	Marks
(salmon pink) solid turns black	1
Total	**1**

Question 29 **(9 marks)**

When hydrogen gas reacts with oxygen gas it burns with a squeaky 'pop' sound. The reaction occurring can be represented by the following equation.

$2\ H_2(g) + O_2(g) \rightarrow 2\ H_2O(g)$

(a) Look at circled section of the equation. Explain the different meanings of the two number 2's in this section of the equation. (2 marks)

Description	Marks
small 2 (subscript) means each molecule contains two (H) atoms	1
large 2 (coefficient) means two (H_2) molecules	1
Total	**2**

(b) At room temperature and normal pressure, one full test tube of hydrogen contains 0.0010 mole of hydrogen gas.

(i) Calculate the mass of this amount of hydrogen gas. (2 marks)

Description	Marks
$m(H_2) = n \times M = 0.0010 \times 2.016$	1
$= 0.002016$ g *or* 2.02×10^{-3} g *or* 2.02×10^{-3} g *(don't penalise significant figures, but must have unit)*	1
Total	**2**

(ii) Calculate the number of moles of oxygen gas that would react with this amount of hydrogen gas. (1 mark)

Description	Marks
moles = (1/2) x 0.0010 = 0.00050 (5.0×10^{-4})	1
Total	**1**

(ii) Calculate the mass of water produced. (2 marks)

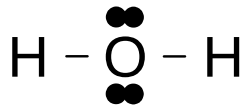
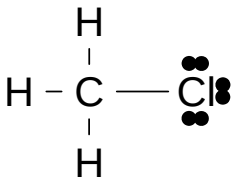
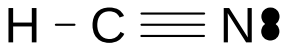
Description	Marks
$n(H_2O) = n(H_2) = 0.0010$	1
$m(H_2O) = n \times M = 0.0010 \times 18.016 = 0.018$ g	1
Total	**2**

(c) **E**xplain why this is an exothermic reaction by referring to the chemical bonds present. (2 marks)

Description	Marks
more energy is released when (new) bonds are formed than is required to break (existing) bonds	1
this energy is released to the surroundings in the form of heat	1
Total	**2**

Question 30 **(3 marks)**

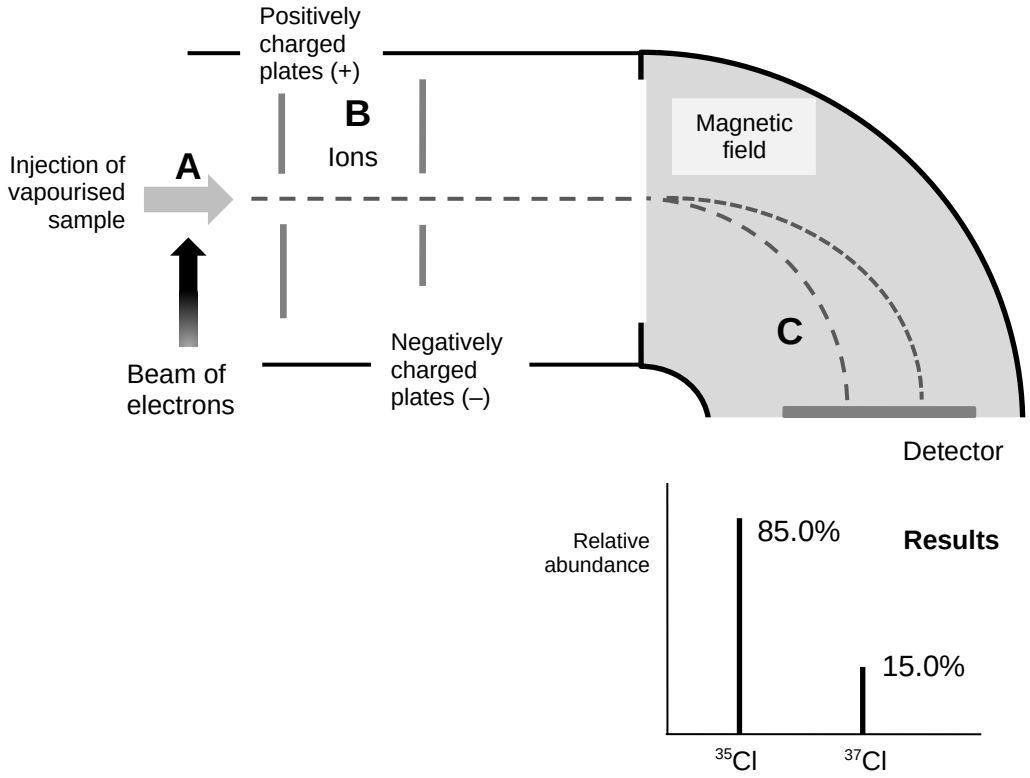
For each molecule listed in the table below draw the structural formula, representing **all** valence shell electron pairs as ⁚ , or as — .

Species	Electron Dot Diagram (Lewis diagram)
Water, H_2O	
Chloromethane, $CH_3C\ell$	
Hydrogen cyanide, HCN	

Description	Marks
each correct structure	3
Total	**3**

Question 31 **(9 marks)**

The diagram below shows a **Mass Spectrometry** apparatus being used to analyse a sample of chlorine, which contains the isotopes chlorine-35 and chlorine-37.



(a) Ionisation of chlorine atoms occurs at **A**. Explain what is meant by the term ionisation in this situation. In your answer explain why energy is required for ionisation to occur. (2 marks)

Description	Marks
the loss of an electron(s) from an atom	1
energy required to overcome the attraction of the (negative) electron(s) to the (positive) nucleus	1
Total	**2**

(b) Write the formula of the ions present at **B**. (1 mark)

Description	Marks
Cl^+	1
Total	**1**

(c) (i) The ions of which isotope are present at **C**? (1 mark)

Description	Marks
chlorine-35	1
Total	**1**

(ii) Explain you answer to part (c) (i). (2 marks)

Description	Marks
they are lighter	1
so will be deflected more by the magnetic field	1
Total	**2**

(d) Use the results shown to calculate the relative atomic mass (atomic weight) of this sample of chlorine. (2 marks)

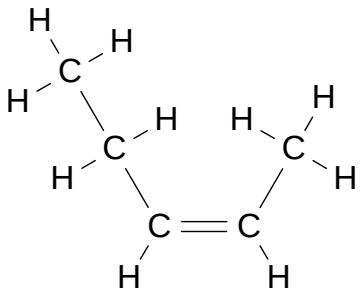
Description	Marks
M(Cl) = (80.0 x 35 + 20.0 x 37) / 100	1
= 35.3	1
Total	**2**

(e) Explain why this sample is probably not naturally occurring chlorine. (1 mark)

Description	Marks
because the relative atomic mass of naturally occurring chlorine is 35.45	1
Total	**1**

Question 32 **(11 marks)**

The structure below shows a molecular structural formula of a straight chain alkene, *cis*-pent-2-ene.



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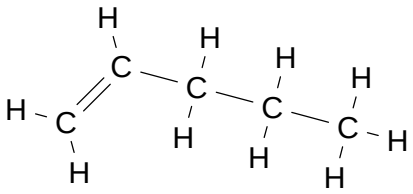
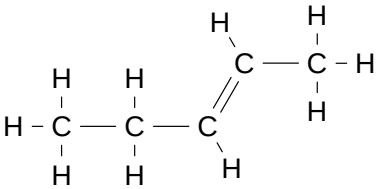
(a) (i) Draw the molecular structural formula and name a **structural** isomer of this compound that is also a straight chain alkene. (2 marks)

Description	Marks
	1
pent-1-ene (no marks if described as cis or trans)	1
Total	**2**

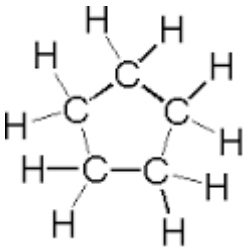
(ii) Draw the molecular structural formula of the geometric (*trans*) isomer of this compound. (2 marks)

Description	Marks
	1
Total	**1**

(b) Draw the condensed molecular structural formula of the product formed when *cis*-pent-2-ene reacts with bromine. (2 marks)

Description	Marks
$CH_3CHBrCHBrCH_2CH_3$ *only one mark if displayed formula is shown, or just $C_5H_{10}Br_2$*	2
Total	**2**

(c) The molecular structural formula of cyclopentane is shown below.



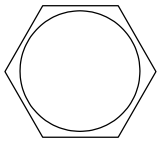
(i) Explain why cyclopentane is an isomer of *cis*-pent-2-ene. (2 marks)

Description	Marks
the (molecular) formula of both *cis*-pent-2-ene and cyclopentane is C_5H_{10}	1
so they have the same formula but different structures	1
Total	**2**

(ii) A student mixed bromine (in the form of bromine water - an aqueous solution of bromine) with cyclohexane. There was no observable change. Explain this observation. (2 marks)

Description	Marks
reaction requires a C=C double bond / an unsaturated molecule	1
cyclohexane only contains single bonds / is saturated	1
Total	**2**

(d) *cis*-pent-2-ene is an alkene, cyclopentane is an alkane. Explain, using a diagram as required, why benzene (C_6H_6) is neither an alkane nor an alkene. (2 marks)

Description	Marks
the bonds in benzene are regarded as intermediate between single and double bonds	1
can be represented as: where the circle represents electrons delocalised around the ring of 6 carbon atoms 	1
Total	**2**

Question 33 **(12 marks)**

Western Australia is rich in deposits of iron ore. The main ore found locally is haematite (Fe_2O_3). Other ores that are extracted commercially include magnetite (Fe_3O_4) which is a magnetic material, and siderite ($FeCO_3$).

In all cases the ores have to be purified (separated from the waste rock and impurities) before being reacted with other chemicals to extract the pure metal from the ore.

(a) Describe a way that magnetite can be separated from other rocks when it is extracted from the ground. (1 mark)

Description	Marks
using a magnet / magnetic field to separate the ore from the rocks	1
Total	**1**

(b) Calculate the percentage by mass of iron in siderite. (2 marks)

Description	Marks
%(Fe) = (55.85/115.86) x 100	1
= 48.2%	1
Total	**2**

(c) (i) Calculate the number of moles of haematite (Fe_2O_3) in 1.00 tonne (1.00 tonne = 1000 kg or 1.00 x 10^6 g). (3 marks)

Description	Marks
$M(Fe_2O_3)$ = 159.7	1
$n(Fe_2O_3)$ = m/M = 1.00 x 10^6 / 159.7 = 6261.7 mol	1
= 6260 mol or 6.26 x 10^3 mol (answer to 3 sig figs)	1
Total	**3**

(ii) When haematite is converted into iron, the following reaction occurs in a blast furnace.

$Fe_2O_3(s) + 3\,CO(g) \rightarrow 2\,Fe(\ell) + 3\,CO_2(g)$

Calculate the mass of carbon dioxide in tonnes produced when 1.00 tonne of haematite is reacted. (3 marks)

Description	Marks
$n(CO_2)$ = (3/1) x $n(Fe_2O_3)$ = (3/1) x 6261.7 = 18 785	1
$m(CO_2)$ = n x M = 18 785 x 44.01 = 826737 g	1
= 0.828 tonnes	1
Total	**3**

(iii) Assuming the reaction is 100% efficient (all iron in the ore is converted into pure iron). Calculate the mass of haematite required to produce each 1.00 kg of iron. (3 marks)

either:

Description	Marks
n(Fe) = 1000/55.85 = 17.905	1
$n(Fe_2O_3)_{required}$ = (1/2) x n(Fe) = (1/2) x 17.905 = 8.953 mol	1
$m(Fe_2O_3)_{required}$ = n x M = 8.953 x 159.7 = 1429.7 g = 1.43 kg	1
Total	**3**

or:

Description	Marks
% Fe in (Fe_2O_3) = ((55.85 x 2) /159.7) x 100	1
= 69.94%	1
$m(Fe_2O_3)_{required}$ = (100/69.94) x 1.00 kg = 1.43 kg	1
Total	**3**

End of Section Two

Section Three: Extended answer **40% (80 Marks)**

This section contains **5** questions. You must answer **all** questions. Write your answers in the spaces provided.

Where questions require an explanation and/or description, marks are awarded for the relevant chemical content and also for coherence and clarity of expression. Lists or dot points are unlikely to gain full marks.

Final answers to calculations should be expressed to the appropriate number of significant figures.

Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.

- Planning: If you use the spare pages for planning, indicate this clearly at the top of the page.
- Continuing an answer: If you need to use the space to continue an answer, indicate in the original answer space where the answer is continued, i.e. give the page number. Fill in the number of the question(s) that you are continuing to answer at the top of the page.

Suggested working time: 70 minutes.

Question 34 **(12 marks)**

A student was given the following mixture to separate into three pure substances:
Silica (SiO_2), sodium chloride ($NaC\ell$) and copper(II) chloride ($CuC\ell_2$).

Solubility data:

	Solubility in water (g/100g) at 25 °C	**Solubility in ethanol (g/100g) at 25 °C**
SiO_2	0.012	nil
$NaC\ell$	36	0.065
$CuC\ell_2$	61	67

Describe a step-by-step method that could be used to separate the three substances. Assume you have access to normal laboratory equipment including Bunsen burners, filter paper and funnels, evaporating dishes, ovens, stirring rods, beakers, flasks, distilled water, ethanol. Ensure that the method includes procedures that are safe.

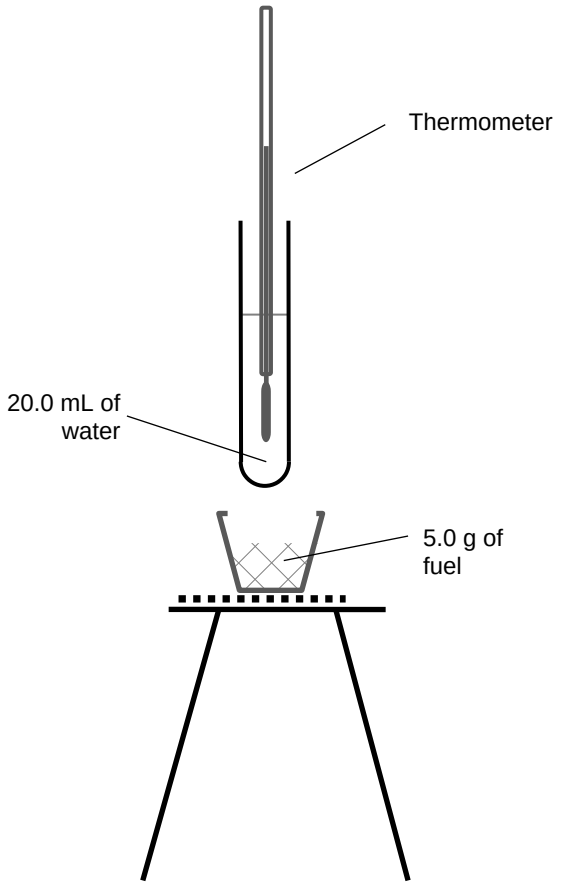
Description	**Marks**
add distilled water to the mixture	1
stir to dissolve	1
filter to remove the silica	1
wash the silica using distilled water	1
dry the **silica** using a Bunsen burner or in the oven	1
evaporate the filtrate / solution from the filtration process	1
dissolve the resulting solid in ethanol	1
stir to ensure all the copper chloride dissolves	1
filter collect the residue	1
dry the residue – this is the **sodium chloride**	1
evaporate the filtrate in oven or avoiding a naked flame	1
until the **copper(II) chloride** crystallises from the solution	1
Total	**12**

Question 35 **(18 marks)**

A student carried out an investigation to measure the amount of energy released from a range of alcohols that can be used as fuels. She wanted to determine whether there was a relationship between the energy released per gram and the relative molecular mass of the alcohol.

She used the increase in the temperature of a fixed amount of water as a measure of the heat released by each fuel. The hypothesis for his experiment was that the energy released from each compound is directly proportional to the molecular mass of the compound.

The equipment was set up as shown below.



Method

1. 5.0 g of the fuel was weighed and placed in the crucible.
2. 20.0 mL of water was poured into a large test tube and placed above the crucible.
3. The temperature of the water was recorded.
4. The fuel was ignited using a match and left to burn until all the fuel had been combusted.
5. The temperature of the water was measured to calculate the increase in temperature of the water.
6. The experiment was repeated for each different fuel.

The results of the experiments are shown below.

Fuel	Formula	Relative molecular mass	Temperature of water (°C)		
			Initial	Final	Increase
Methanol	CH_3OH	32.0	22	52	30
Ethanol	C_2H_5OH	46.1	22	89	45
Propanol	C_3H_7OH	60.1	26	78	52
Butanol	C_4H_9OH		Butanol not available		
Pentanol	$C_5H_{11}OH$	88.1	24	82	58

(a) For this experiment, name

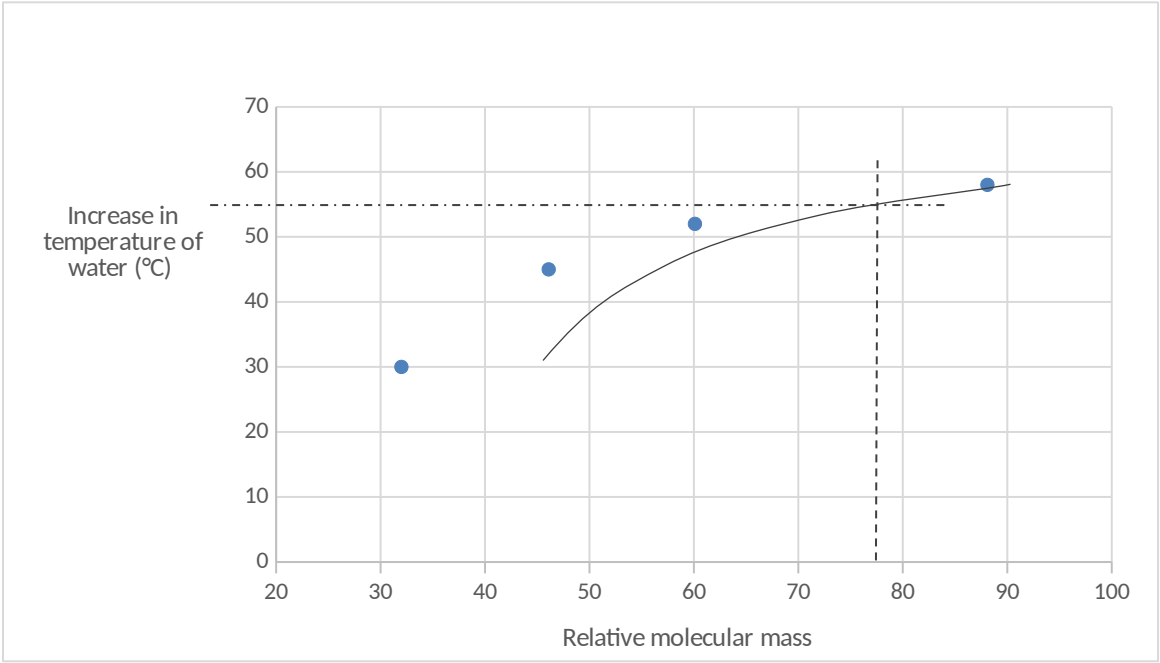
(i) the independent variable. (1 mark)

Description	Marks
The relative molecular mass of the fuel (don't accept just type of fuel	1
Total	**1**

(ii) **four** controlled variables. (2 marks)

Description	Marks
any four from: • volume of water • mass of fuel • height of test tube above crucible • size and (shape) of test tube • size and shape of crucible • surrounding temperature *2 correct = 1 mark 4 correct = 2 marks*	0 – 2
Total	**2**

(b) On the grid below, draw a graph showing the relationship between the increase in temperature and the molecular mass of the fuel. (5 marks)



Description	Marks
correct scales	1
label axes	1
units for temperature	1
points correctly plotted	1
line drawn – can be straight line of best fit or curve	1
Total	**5**

Marking Key

(c) (i) Calculate the relative molecular mass of butanol. (1 mark)

Description	Marks
$M_R(C_4H_7OH) = 72.10$	1
Total	**1**

(ii) Use your graph to predict the temperature increase that would be expected for butanol. (Show your working on the graph) (2 marks)

Description	Marks
53 – 56 °C	1
working (lines) shown on graph	1
Total	**2**

(d) Consider the method described for this experiment.

(i) State one possible source of **random** error in the experiment. (1 mark)

Description	Marks
any one from: • measurement of volume of water • weighing the mass of fuel • measuring the initial and final temperatures	1
Total	**1**

(ii) State one possible source of **systematic** error in the experiment. (1 mark)

Description	Marks
any one from: • loss of the fuel when transferred to the crucible (after weighing) • loss of heat to the surroundings • other sensible suggestions	1
Total	**1**

(iii) It was suggested to the student that she should repeat the trials for each fuel three times to remove the systematic error. Evaluate this suggestion. (3 marks)

Description	Marks
suggestion is incorrect	1
systematic errors are always on one side of the actual value of the measurement	1
repeating the trials (and taking an average) would not remove the error as the average of the results would still be either above, or below the actual value	1
Total	**3**

(g) Discuss whether you think the results from the experiment prove or disprove the hypothesis. (2 marks)

Description	Marks
hypothesis not proved	1
energy released increases with molecular mass, but it is not a proportional (linear) relationship / not a clear straight line on the graph	1
Total	**2**

Question 36 **(16 marks)**

Read the text below regarding the use of ethanol in petrol and answer the questions that follow.

Background

Unleaded E10 contains 10% ethanol and 90% petrol.

Unleaded E85 contains up to 85% ethanol.

Ethanol has the formula C_2H_5OH and combusts in oxygen as shown below:

$C_2H_5OH + 3\ O_2 \rightarrow 2\ CO_2 + 3\ H_2O$

The main component in petrol is **octane** (C_8H_{18}) and combusts in oxygen as shown below:

$2\ C_8H_{18} + 25\ O_2 \rightarrow 16\ CO_2 + 18\ H_2O$

Enhanced Petrol and Engine Performance – from advertisement

Using Unleaded E10 can make a real difference to Australia's environment. Unleaded E10 contains 3.55% oxygen, resulting in a cleaner burning fuel. Using Unleaded E10 will reduce the amount of harmful greenhouse gas (such as carbon dioxide) emissions. Unleaded E10 very significantly lowers smog causing emissions including carbon monoxide and hydrocarbons as compared to regular unleaded fuels.

The manufacture and use of Unleaded E10 can help our economy in a number of ways, including;

- Reducing our dependency on imported oil
- Creating the potential for future job opportunities for Australians
- Assisting in stimulating growth in Regional Australia
- Helping to build a renewable fuel industry

Adapted from: http://www.unitedpetroleum.com.au/united/fuel/unleaded-e10

Ethanol put to the test: E85 v E10 v premium unleaded – from motor news article

As the world grows increasingly concerned by our declining oil supplies, car makers are trying to find the best replacement. There are those who believe the solution can be found in sugar cane fields. Ethanol is claimed to significantly reduce CO_2 emissions because it uses materials that absorb CO_2 during the growing process.

Already some enthusiasts are modifying their cars to run on E85 - a blend of petrol and up to 85 per cent ethanol - to take advantage of the increased performance.

Adapted from: http://www.drive.com.au/motor-news/ethanol-put-to-the-test-e85-v-e10-v-premium-unleaded-20110205-1ahgx.html

(a) Ethanol is described as a biofuel.

Marking Key

- Describe what is meant by a biofuel
- Explain the advantages of biofuels compared to fossil fuels such as petrol, and
- Describe one environmental or economic problem of using materials such as sugar cane to produce biofuels. (6 marks)

Description	Marks
biofuels are produced from animal or plant matter	1
biofuels are renewable as the plants can be regrown to provide new fuel (in a relatively short time frame).	1
therefore they are a more sustainable source of fuel that fossil fuels that cannot be replaced in short time frames	1
carbon dioxide, a greenhouse gas, is absorbed from the atmosphere when these bio crops are grown (thus reducing the impact of carbon dioxide on climate change	1
land that might be needed for food crops are instead being used for biofuels	1
which could lead to reduction in food security / production (accept other biofuels issues)	1
Total	**6**

(b) By comparing the combustion equations of the two compounds, evaluate the statement: “Using Unleaded E10 will reduce the amount of harmful greenhouse gas”. (4 marks)

Description	Marks
the greenhouse gas produced by the fuel is carbon dioxide (and water vapour)	1
$C_2H_5OH + 3\ O_2 \rightarrow 2\ CO_2 + 3\ H_2O$ $2\ C_8H_{18} + 25\ O_2 \rightarrow 16\ CO_2 + 18\ H_2O$ from the equation, burning one mole of ethanol will release 2 moles of CO_2 into the atmosphere comparted to one mole of octane which will release 8 moles of CO_2 into the atmosphere.	1
there will be a reduction in greenhouse gas emissions if ethanol is mixed with the petrol	1
but only minor because the fuel is still 90% petrol	1
Total	**4**

(c) Examine this claim from the text:

"Unleaded E10 contains 3.55% oxygen, resulting in a cleaner burning fuel."

(i) Using the atomic weights on your data sheet, calculate whether this statement is accurate and comment on your findings. (4 marks)

Description	Marks
$M(C_2H_5OH) = 46.068$	1
%(O) = (16.00/46.068) x 100 = 34.7%	1
if ethanol makes up 10% of total fuel, % in total = 34.7 / 10 = 3.47%	1
this is slightly lower than the claim stated but relatively accurate	1
Total	**4**

(ii) Discuss whether you think that it is the percentage of oxygen in a fuel that will determine whether it is a 'cleaner burning fuel' (2 marks)

Description	Marks
greenhouse gases, such as carbon dioxide are formed from the carbon in the fuel.	1
therefore, the percentage of carbon in the fuel may be a better indicator of how clean the fuel will burn. *accept other logical and correct responses*	1
Total	**2**

Question 37 **(19 marks)**

Carbon can exist in the form of two common allotropes, graphite and carbon, as well as a range of fullerenes such as C_{60} (also known as a 'Buckyball').

(a) Using your knowledge of structure and bonding, and using diagrams, compare and explain the following properties of graphite and diamond.

- Melting point
- Hardness
- Electrical conductivity in the solid state (10 marks)

Description	Marks
Diamond diagram marking points	
diagram clearly shows carbon atoms joined to 4 other carbon atoms	1
Graphite diagram marking points	
diagram clearly shows carbon atoms joined to 3 other carbon atoms within the layers and weak bonding between the layers	1
Melting point	
Diamond: very high due to strong covalent bonds throughout the lattice/network	1
Graphite: high due to strong covalent bonds throughout the layers	1
Hardness	
Diamond: extremely hard due to strong covalent bonds throughout the lattice/network. Can't break one bond without affecting another	1
Graphite: softer due to weak bonds between the layers	1
which allow the layers to slide past each other	1
Electrical conductivity	
Diamond: non-conductor – no ions or electrons / charged particles free to move / all electrons involved in bonding	1
Graphite: conductor – electrons that are not involved in bonding are free to move through the structure / between the layers	1
the electrons can therefore carry the current	1
Total	**10**

(b) Describe one use of diamond and one use of graphite that is dependent of one of the properties listed above. You can use a different property for each material. In your answer, explain how the property makes the material suitable for that use.

(6 marks)

Description		Marks
Diamond	**Graphite**	
Use		
any one from these: • jewellery • cutting instruments such as drill bits and coating saw blades	*any one from these:* • carbon sports equipment • pencil leads, lubricant • electrodes	2
Property		
• can be cut into crystal shapes • very hard	• high strength and flexibility • soft • conducts electricity	2
Reasoning (examples)		
• the regular shape of the diamond structure allows it to be cut into shapes with hard edges • the diamond is so hard it will cut other substances whilst maintaining its own shape	• the sports equipment needs to strong, and light • graphite pencil leads deposit a layers of graphite n the paper • electrodes require a high conductivity	2
	Total	**6**

(c) Fullerenes are classified as nanomaterials. Describe one risk of the use of nanomaterials and explain how that risk has been reduced.

(3 marks)

example of answer – other possibilities can gain full marks

Description	Marks
nanoparticles are small enough to pass into body cells	1
much of the long term effect of nanoparticles is not known yet	1
further research is being carried out / regulations to limit the use of nanomaterials is being developed	1
Total	**3**

Question 38 **(15 marks)**

Alloys are mixtures of metals, combined together to produce materials with properties suitable for a variety of uses. Australian coins are made of two different metal alloys.

- 'Silver' coins (5, 10, 20, 50 cent coins) are made from an alloy of 75% copper and 25% nickel, often called cupronickel.
- 'Gold' coins (1 and 2 dollars) are made from alloy of 92% copper and 8% aluminium called aluminium bronze or AlBr.

(a) Copper is present in both alloys because it is a highly malleable metal. Describe what malleable means and use your knowledge of metallic bonding to explain why metals are malleable. Use a diagram in your answer. (6 marks)

Description	Marks
malleable means that the material can be reformed into different shapes	1
metallic bonding consists of positive ions held together in a 'sea' of delocalised electrons	1
labelled diagram of metallic bonding	1
diagram shows some movement of the structure	1
the bonding is non-directional	1
the arrangement/position of the ions can be changed without reducing the forces of attraction that hold the metal together. (this can be shown on the diagram)	1
Total	**6**

(b) Silver atoms have a larger atomic radius than copper atoms. Suggest why adding silver to copper will make the alloy harder (less malleable) than the pure copper. Use a diagram in your answer. (3 marks)

Description	Marks
the different sizes/radii will make it more difficult for the 'layers' of metals to slide past each other	1
so it is harder to change the shape	1
clear labelled diagram	1
Total	**3**

(c) Explain why AlBr is **not** a true chemical formula. (2 marks)

Description	Marks
Br is not representing a chemical element	1
The ratio of Al to Br(bronze) in the alloy is not 1:1	1
Total	**2**

(d) Explain why alloys are described as homogeneous mixtures. (2 marks)

Description	Marks
they have uniform composition	1
and properties throughout the substance	1
Total	**2**

(e) Cupronickel alloy is denser than aluminium bronze. Suggest a reason, with evidence, for this. (2 marks)

Description	Marks
the atomic mass of nickel, 58.69, is greater	1
than that of aluminium, 26.98.	1
Total	**2**

End of questions