**Year 11 Unit 1 Examination, 2017**

**CHEMISTRY Solutions**

**Section One: Multiple-choice 17% (30 Marks)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 1. | a 🞏 | b 🞏 | c 🞏 | d 🞏 |
| 2. | a 🞏 | b 🞏 | c 🞏 | d 🞏 |
| 3. | a 🞏 | b 🞏 | c 🞏 | d 🞏 |
| 4. | a 🞏 | b 🞏 | c 🞏 | d 🞏 |
| 5. | a 🞏 | b 🞏 | c 🞏 | d 🞏 |
| 6. | a 🞏 | b 🞏 | c 🞏 | d 🞏 |
| 7. | a 🞏 | b 🞏 | c 🞏 | d 🞏 |
| 8. | a 🞏 | b 🞏 | c 🞏 | d 🞏 |
| 9. | a 🞏 | b 🞏 | c 🞏 | d 🞏 |
| 10. | a 🞏 | b 🞏 | c 🞏 | d 🞏 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 11. | a 🞏 | b 🞏 | c 🞏 | d 🞏 |
| 12. | a 🞏 | b 🞏 | c 🞏 | d 🞏 |
| 13. | a 🞏 | b 🞏 | c 🞏 | d 🞏 |
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| 15. | a 🞏 | b 🞏 | c 🞏 | d 🞏 |
| 16. | a 🞏 | b 🞏 | c 🞏 | d 🞏 |
| 17. | a 🞏 | b 🞏 | c 🞏 | d 🞏 |
| 18. | a 🞏 | b 🞏 | c 🞏 | d 🞏 |
| 19. | a 🞏 | b 🞏 | c 🞏 | d 🞏 |
| 20. | a 🞏 | b 🞏 | c 🞏 | d 🞏 |

**Section Two: Short answer 37% (55 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: 55 minutes.

**Question 21 (8 marks)**

(a) Write the formula of each of the following compounds. (4)

|  |  |
| --- | --- |
| **Name** | **Formula** |
| sodium sulfide | **Na2S** |
| copper (II) sulfate | **CuSO4** |
| aluminium carbonate | **Aℓ2(CO3)3** |
| nitrogen dioxide | **NO2** |

(b) Write the names of each of the following species. (4)

|  |  |
| --- | --- |
| **Formula** | **Name** |
| Zn(NO3)2 | **Zinc nitrate** |
| NH4+ | **Ammonium ion** |
| SO3 | **Sulfur trioxide** |
| FeCℓ2 | **Iron (II) chloride** |

**(b) Half a mark is given if one part of the name of an ionic compound is correct.**

**Question 22 (11 marks)**

(a) **Draw** a full structural formula and **name** the straight chain isomer of a saturated hydrocarbon containing five carbon atoms (3)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Isomer correctly drawn | 2 |
| Isomer drawn with one small error (e.g. missing one hydrogen atom) | 1 |
|  |  |
| Pentane | 1 |
| Total | 3 |

**If the structure is incorrect then no follow on for the name.**

(b) Give the **molecular** **formula** and **draw** a full structural formula for 1,2 –dibromo-2-methylbutane. (3)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| C5Br2H10 | 1 |
| Structure correctly drawn | 2 |
| Structure drawn with one small error (e.g. missing one hydrogen atom) | 1 |
|  |  |
| Total | 3 |

(c) **Draw** a full structural formula and **name** a branched chain isomer of C5H10 that could be used to create the compound in part (b). (3)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Isomer correctly drawn | 2 |
| Isomer drawn with one small error (e.g. missing one hydrogen atom) | 1 |
|  |  |
| 2-methylbut-1-ene | 1 |
| Total | 3 |

**Halogenation not accepted since this can be used for substitution or addition**

**If name is correct for incorrect structure, follow on has been paid however this is not done in the WACE you MUST have structure correct before name is considered.**

**This has only been this time since part (d) is based on part (c).**

**Marks are given if the condensed formula is drawn instead of the full structural formula.**

**Follow on marks have been awarded for part (d) if part (c) is incorrect**

(d) Name the type of chemical reaction and any chemical(s) required to carry out this conversion from chemical (c) to chemical (b). (2)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Addition | 1 |
| Bromine water/aqueous bromine//Br2(aq)/Br2(l) | 1 |
| Total | 2 |

**Question 23 (6 marks)**

**Draw** and **name** the geometric isomers of but-2-ene and use them to explain this type of isomerism.

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Each isomer drawn correctly to distinguish cis-trans isomers but full structural formula not required | 2 |
| **or** One isomer drawn showing either cis or trans version correctly | 1 |
| 1 Mk taken off if H atoms not shown attached to C atoms |  |
| *Cis*-but-2-ene | 1 |
|  |  |
| *Trans-* but-2-ene | 1 |
| Total | 4 |

|  |  |
| --- | --- |
| **Description** | **Marks** |
| One mark for each point made up to a maximum of two marks. |  |
| Answers may include but are not limited to the following:   cis/trans isomers have the same structural formula but different shape/geometry   cis/trans isomers exist in alkenes only (or in hydrocarbons with a double bond)   in a cis isomer the H’s are both on the same side of the double bond whereas in a trans isomer the H’s are on opposite sides of the double bond | 1-2 |
| 1Mk for C=C does not allow rotation + 1 Mk for cis – trans explanation.Total | 2 |

**Question 24 (5 marks)**

(a) Draw a full structural formula of benzene. (2)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Structure correctly drawn | 2 |
| Structure drawn with one small error (e.g. missing one hydrogen atom) | 1 |
| oror |  |
| 2 Mks for Benzene ring with circle and zero Mks for cycloalkenes & anesTotal | 2 |

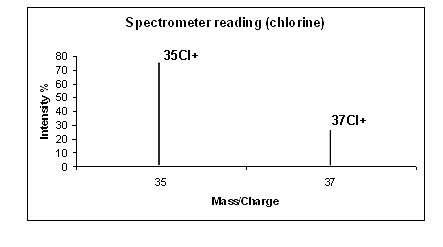
(b) Write a molecular equation and name the main organic product when benzene undergoes single substitution with chlorine gas (Cℓ2) in the presence of UV light.

|  |  |
| --- | --- |
| **Description** | **Marks** |
| C6H6 + Cℓ2 → C6H5Cℓ + HCℓ UV catalyst | 2 |
| One error or omission + follow via Mks given if benzene structure was wrong | 1 |
| Chlorobenzene - 1 mark | 1 |
| Total | 3 |

**Question 25 (7 marks)**

(a) What analytical technique was used to produce the graph below? (1)

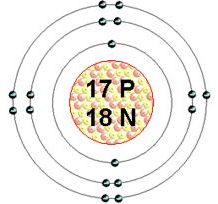
|  |  |
| --- | --- |
| **Description** | **Marks** |
| Mass spectrometry: zero marks given for mass spectroscopy (0) | 1 |



(b) Use the information in the graph above to calculate the approximate relative atomic mass of chlorine. (2)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Accept (72-77)% Cℓ-35 and (23-28)% Cℓ-37 : % Cl >77% and Cl > 28% = 0 | 1 |
| Calculation based on 75% Cℓ-35 and 25% Cℓ-37  75/100x35 + 25/100x37 = 35.5 : 1 Mk for the correct answer | 1 |
| Total | 2 |

(c) Draw and label a diagram of a Cℓ-35 atom showing the location of the nucleus; the number and type of particles in the nucleus and the electron levels. (4)

****

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Correctly identifies the nucleus | 1 |
| Correctly shows the contents of the nucleus (17 protons and 18 neutrons).  N.B. these may be drawn as dots but the number of each should be approximately correct : Students not penalised if nucleus not labelled | 1 |
| Shows electron levels around the nucleus (3 levels) | 1 |
| Correctly shows number of electrons in each level (2,8,7) N.B. a variety of symbols is acceptable to represent electrons such as dots or crosses | 1 |
| Total | 4 |

**Question 26 (5 marks)**

Consider the information about some pure substances.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Substance | Melting point (oC) | Boiling point  (oC) | Electrical conductivity in solid state | Electrical conductivity in liquid state | Solubility in water |
| 1 | 1535 | 2750 | good | good | insoluble |
| 2 | 800 | 1410 | non | good | soluble |
| 3 | -259 | -253 | non | non | insoluble |
| 4 | 1710 | 2590 | non | non | insoluble |
| 5 | 50 | 265 | non | non | insoluble |

Choose **one** of the substances above that is most likely: Marks given as below in the answers

(a) a **gas** at room temperature? (1)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Substance 3 | 1 |

(b) to be a **covalent molecular solid**? (1)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Substance 5 | 1 |

(c) to be a **metal**? (1)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Substance 1 | 1 |

(d) likely a **covalent network** substance? (1)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Substance 4 | 1 |

(e) an **ionic** substance? (1)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Substance 2 | 1 |

**Question 27 (10 marks)**

Consider the following chemical reaction in which methane gas (CH4) reacts in excess oxygen gas.

CH4(g) + 2 O2(g) → CO2(g) + 2 H2O(g)

**If setting out did not include information like shown in red - ½ mark to a maximum of 1 mark**

**Units not shown – ½ mark to a maximum of 1 mark**

(a) How many **moles** of methane are in 10.0 g of methane gas? (1)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| **n(CH4)** = 10.0/16.042 = 0.623 mol | 1 |

(b) How many **moles** of oxygen gas are required to completely react with 1.85 mol of methane gas? (1)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| **n(O2) =** 2 x n(CH4) = 2x 1.85 = 3.70 mol | 1 |

(c) What **mass** of carbon dioxide gas is produced from the complete combustion of 25.0 g of methane? (3)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| n(CH4) = 25.0/16.042 = 1.558 mol | 1 |
| n(CO2) = n(CH4) = 1.558 mol Must show this step for full marks | 1 |
| m(CO2) = 1.558 x 44.01 = 68.6 g | 1 |
| Total | 3 |

(d) What is the **mass** of 3.60 moles of methane? (1)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| m(CH4) = 3.60 x 16.042 = 57.8 g | 1 |

(e) What **mass** of water vapour is produced by complete combustion of 2.50 mol of methane? (2)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| n(H2O) = 2 x n(CH4) = 2 x 2.50 = 5.00 mol | 1 |
| m(H2O) = 5.00 x 18.016 = 90.1 g | 1 |
| Total | 2 |

(f) Determine the percentage composition of methane. (2)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| %C = m(C)/m(CH4) x 100 = 12.01/16.042 x 100 = 74.9 % | 1 |
| %H = 100 - %C = 100 – 74.9 = 25.1 %  OR  % H = m(H)/m(CH4) x 100 = 4.032/16.042 x 100 = 25.1 % | 1 |
| Total | 2 |

**Question 28 (3 marks)**

Balance the following equations

(a) CuO + **2** HNO3 → Cu(NO3)2 + H2O (1)

(b) **2** Aℓ + **6** HCℓ → **2** AℓCℓ3 + **3** H2 (1)

Aℓ + **3** HCℓ → AℓCℓ3 + **3/2** H2

(c) **2** C2H6 + **7** O2 → **4** CO2 + **6** H2O (1) **or** C2H6 + **7/2** O2 → **2** CO2 + **3** H2O  **End of Section Two**

**Section Three: Extended answer 43% (65 Marks)**

This section contains **4** 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 ofsignificant figures.

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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: 65 minutes.

**Question 29 (16 marks)**

Diamond and graphite are two allotropes of carbon with distinctly different covalent network structures and physical properties. Compare them in terms of the following points.

(a) Covalent network structure.

(i) **Label the following** on the appropriate diagram. (4)

**Did not ask to draw lines from words to diagram**

*Diamond Graphite covalent bond carbon atom*

|  |  |
| --- | --- |
| **Description** | **Marks** |
| One mark per correct label  N.B. *carbon atom* and *covalent bond* do not need to be labelled on both structures | 1-4 |
| Total | 4 |

**Questions should be answered in a positive way not negative ie graphite is not like diamond**

(ii) **Compare** the covalent network **structures** of both diamond and graphite. (4)

**Question did NOT ask for PROPERTIES**

|  |  |
| --- | --- |
| **Description** | **Marks** |
| One mark for each point mentioned up to a maximum of four marks. Two points must be about graphite and two about diamond. |  |
| Answers may include, but are **not** limited to the following:   Diamond has a 3D structure/lattice/array   graphite has a 2D structure/lattice   Diamond’s carbons are attached to 4 others   Graphite’s carbons are attached to 3 others   Graphite’s structure consists of layers (of graphene) | 1-4 |
| Total | 4 |

(b) Electrical conductivity.

(i) Explain **why** diamond does not conduct electricity. (2)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Each carbon has 4 electrons and they are all covalently bonded to other carbon atoms | 1 |
| (therefore) diamond has no freely moving electrons | 1 |
| Total | 2 |

(ii) Explain **why** graphite does conduct electricity. (2)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Each carbon has 4 electrons and only 3 are covalently bonded to other carbon atoms therefore | 1 |
| one free electron per carbon atom ( unbonded /delocalised electrons) allows graphite to conduct electricity. | 1 |
| Total | 2 |

(c) Hardness of the solid. **(Must relate to structure)**

**Reasons can not be repeated. If two reasons stated as one max 1½ marks**

(i) Give two reasons **why** diamond is so hard? (2)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Strong covalent bonds exist between the **carbon atoms** (in a) | 1 |
| **rigid** **( ½ only)**3D **lattice** (atoms cannot move to different positions) | 1 |
| Total | 2 |

(ii) Give two reasons **why** graphite is soft (2)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Graphite consists of layers (with weak forces of attraction between layers) | 1 |
| (therefore) layers can slide causing it to be soft | 1 |
| Total | 2 |

**Diamond and Graphite do not contain molecules therefore not intermolecular or intramolecular they are intra-atomic between carbon atoms ie covalent bonds and inter-atomic between graphite layers. No penalty for using molecule this time but if inter and intra used incorrectly penalty given.**

**Question 30 (16 marks)**

(a) What was Neils Bohr’s contribution to the understanding of atomic structure? (2)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| One mark for each point mentioned up to a maximum of two marks. |  |
| Answers may include but are **not** limited to the following:   Only certain radii (for the circular orbit) of electrons (around the nucleus) are allowed   Electrons in each orbit have a specific amount of energy   Electrons in the lowest radius orbit (ground state) have the lowest possible energy   Electrons orbit without losing energy   An electron moving from a higher orbit to a lower orbit emits a single photon of light   An electron moving from a lower orbit to a higher orbit absorbs energy of a specific wavelength | 1-2 |
| Total | 2 |

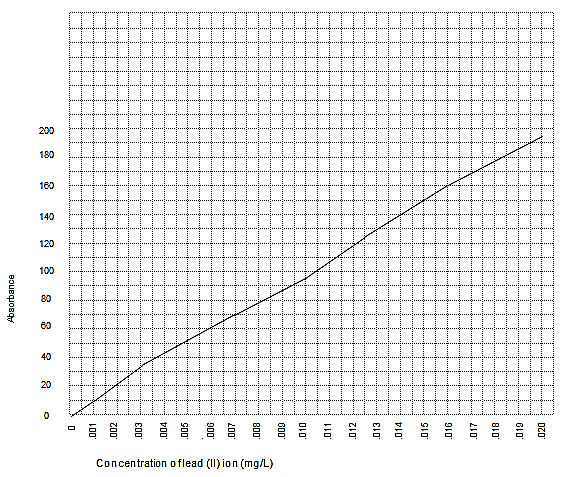
(b) How does his contribution explain analytical techniques such as Flame tests and Atomic Absorption Spectroscopy? (3)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| One mark for each point mentioned up to a maximum of three marks. One point must refer to flame tests and another point must refer to AAS |  |
| Answers may include but are not limited to the following:  **Flame tests**   Flame tests use the unique nature of the electron transitions of an (metal) element to identify that element in a mixture   In a flame test a sample is heated by the Bunsen flame (and the heat excites electrons) which emit a characteristic colour flame (when returning to the ground state)  **AAS**   AAS use the unique nature of the energy absorbed by electrons of an (metal) element to identify an element in a mixture   In AAS light of a particular wavelength (corresponding to a certain element) is passed through a vaporised sample and the degree of absorbance is measured (corresponding to the concentration of the element). | 1-3 |
| Total | 3 |

(c) A drinking water sample was thought to be contaminated with lead (II) ions. The absorbance readings, on an Atomic Absorption Spectrometer, of some **known** samples of lead (II) ions are shown below. Draw a **graph** showing the relationship between lead (II) ion concentration and the absorbance level. (5)

|  |  |
| --- | --- |
| Concentration of lead (II) ion (mg L-1) | Absorbance |
| 0.0010 | 10 |
| 0.0030 | 35 |
| 0.0070 | 70 |
| 0.010 | 95 |
| 0.013 | 125 |
| 0.016 | 160 |
| 0.020 | 195 |

Graph showing lead ion concentration and absorbance readings



*Note: A spare grid is provided at the end of the examination if required*

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Correctly numbered horizontal scale starting at zero | 1 |
| Correctly numbered vertical scale starting at zero | 1 |
| Both axes labelled | 1 |
| Points correctly plotted | 1 |
| Line of best fit or points joined neatly (through zero) Cannot receive marks for line of best fit if points aren’t correctly plotted | 1 |
| Total | 5 |

(d) The suspect drinking water sample was then tested on the same Atomic Absorption Spectrometer and the absorbance measured at 105. Determine if the water is safe to drink and give your reasoning in the space below.(The maximum acceptable level of lead in drinking water has been established by the National Health and Medical Research Centre at 0.01 mg/L)(2)

*Source:* [*https://www.nhmrc.gov.au/guidelines-publications/eh52*](https://www.nhmrc.gov.au/guidelines-publications/eh52)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Water NOT safe to drink Must answer question | 1 |
| Absorbance reading of 105 corresponds to number interpolated from graph | 1 |
| Total | 2 |

(e) The water sample was retested using a different atomic absorption spectrometer and the lead (II) ions level was found to be below the guideline (below 0.01mg/L). Describe an error that could account for this difference in results. (2)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Two marks for each point mentioned up to a maximum of two marks. A brief description of the error must be given for the two marks. |  |
|  any error associated with fluctuations in readings due to changes in temperature or similar during the experiment   Any error associated with the limit of precision of the instrument  Incorrect use of instrument   Instrument not zeroed correctly   Parallax error   using instrument under different conditions (e.g. temperature) from which it was intended/calibrated. Instrument not calibrated correctly  This couldn’t just say machine not working. Had to be specific about the error | 2 |
| Total | 2 |

(f) Describe how the scientist/s conducting this test could improve the reliability of their results. (2)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Conduct repeat trials | 1 |
| And calculate an average  Or include more standards in the calibration curve. | 1 |
| Total | 2 |

**Question 31 (15 marks)**

Refer to the properties of some elements in the same Period below to answer the following questions.

|  |  |  |  |
| --- | --- | --- | --- |
| Element | Relative atomic radius | Relative electronegativity | Number of valence electrons |
| A | Small | medium | 4 |
| B | Medium | low | 2 |
| C | Large | low | 1 |

.

(a) Explain (Cannot give trends on periodic table. Not what the question is asking) the trend in atomic radius and number of valence electrons. (3)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| As atomic radius increases the number of valence electrons in these elements decreases | 1 |
| The explanation may include but are **not** limited to the following:   (As they are all in the same period) they all have the same number of electron levels   More valence electrons means a larger positive charge on the nucleus   Since larger positive charge pulls the electrons closer to the nucleus this decreases the size of the atom/atomic radius | 1-2 |
| Total | 3 |

(b) Explain (Cannot give trends on periodic table. Not what the question is asking) the trend in the number of valence electrons and electronegativity. (3)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| As the number of valence electrons increases the electronegativity increases or vice versa | 1 |
| The explanation may include but are **not** limited to the following:   (As they are all in the same period) they all have the same number of electron levels   More valence electrons means a larger positive charge on the nucleus   This larger positive charge allows the atom to have a stronger attraction for (a bonding pair of) electrons hence higher electronegativity | 1-2 |
| Total | 3 |

Sodium and chlorine are reactive elements with distinctly different physical and chemical properties. The chemically stable compound formed from these two elements has completely different properties to either element. The reactivity or stability of these three substances is related to their valence electrons.

(c) Explain these statements, **in terms of their valence electrons**, by completing the following table. (9)

|  |  |  |
| --- | --- | --- |
| **Statement** | **Explanation** | **Marks** |
| Sodium is a reactive element | One mark per point up to 2 marks | 1-3 |
| Answers may include but are not limited to the following:   * Sodium has 1 valence electron * One valence electron is easily ‘lost’ (to another element/to chlorine) * This allows a sodium ion to have a full electron shell/noble gas electron configuration **Diagram (1 mark)** |
| Chlorine is a reactive element | One mark per point up to 2 marks | 1-3 |
| Answers may include but are not limited to the following:   * Chlorine has 7 valence electrons/is 1 electron short of a full shell/noble gas configuration * One valence electron is easily ‘taken’ (from another element/sodium) * This allows a chloride ion to have a full electron shell/noble gas electron configuration   **Diagram 1 mark -1/2 no non-bonding electrons** |
| The chemically stable compound formed from these elements has completely different properties to either element | One mark per point up to 2 marks | 1-3 |
| Answers may include but are not limited to the following:   * Sodium chloride is a (chemically) stable (white) solid/crystalline (salt) while chlorine is a yellow green gas and sodium is a soft grey metal * It is stable as each contributing ion has a noble gas electron configuration * Sodium chloride is hard and brittle and has a high melting point (in comparison to the elements sodium and chlorine)   **Diagram 1 mark -1/2 no non-bonding electrons** |

**Question 32 (18 marks)**

Biodiesel can be made from something as simple as used vegetable oil or on a larger scale from crops such as soybeans. Biodiesels are likely to be increasingly used as an alternative to fossil fuels and are considered to have several benefits in comparison to fossil fuels. They can be made from the waste material of food crops such as soybean and produce less carbon dioxide emissions. Other studies suggest that large scale production of biofuels may use land otherwise needed for food crops and that the entire process of producing and transporting biofuels can generate more carbon dioxide than is saved.

*Adapted from* [*http://www.explainthatstuff.com/biofuels.html*](http://www.explainthatstuff.com/biofuels.html)

(a) (i) What is a fossil fuel? (1)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| An energy source produced from the decayed remains of animals and plants | 1 |
| **If either plants or animals is omitted, -0.5** Total | 1 |

(ii) Give one example of a fossil fuel (0.5)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Crude oil, natural gas, coal, | 0.5 |
| Total | 0.5 |

(b) (i) What is a biofuel? (1)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| Fuels that are produced from biodegradable materials such as crops | 1 |
| **Must mention plants and animals as sources otherwise -0.5. If they write ‘such as crops/plants it is fine. Must mention ‘biodegradable’ or ‘renewable’ or ‘environmentally friendly’** Total | 1 |

(ii) Give one example of a biofuel other than biodiesel (0.5)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| biogas or bioethanol **or biogasoline** | 0.5 |
| **Or ethanol** Total | 0.5 |

A typical equation for the complete combustion of biodiesel is shown below.

C19H36O2 + 27 O2 → 19 CO2 + 18 H2O

*Source: http://biofuel.org.uk/how-do-biofuels-burn.html*

(c) Determine the mass of CO2 emissions produced from 1.00 kg of biodiesel. (3)

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| --- | --- |
| **Description** | **Marks** |
| Conversion of mass to moles  n(C19H36O2) = 1000/(19x12.01 + 36x1.008 + 2x16.00) = 3.373 mol | 1 |
| Recognition of mole ratio  n(CO2) = 19 x n(C19H36O2) = 64.09 mol | 1 |
| Conversion of moles to mass  m(CO2) = 64.09 x 44.01 = 2820 g (2.82 x 103 g) (2.82 kg) | 1 |
| **-0.5 for wrong molar mass calcs**. Total | 3 |

(d) Given that 1.00 kg of biodiesel has a volume of about 1.14 L; determine the mass of carbon dioxide emissions from burning 1.00 L of biofuel. (2)

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| --- | --- |
| **Description** | **Marks** |
| Recognition that previous answer (2820 g) results from 1.14 L of biodiesel  m(CO2) from 1.14 L = 2820.4 g | 1 |
| Uses ratios to determine mass of CO2 from 1.00 L  m(CO2) from 1.00 L = 1.00/1.14 x 2820.4 g = 2474 g (2.74 x 103 g) (2.74 kg) | 1 |
| **For second mark, students could use n = m/M**  **using m(biodiesel) = 0.877 g** **or follow through values** Total | 2 |

Petrodiesel (normal diesel) is a mixture of hydrocarbons and as such a single chemical equation does not exist for the combustion of diesel.

(e) The equation below is the accepted “average” equation for the complete combustion of diesel. If 1.00 L of diesel has a mass of 0.832 kg determine the mass of CO2 gas produced from 1.00 L of diesel. (4)

[4 C12H23  + 71 O2  → 48 CO2  + 46 H­2O](http://www.altfuels.org/backgrnd/fuelchem.html)

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| --- | --- |
| **Description** | **Marks** |
| Recognition that using 0.832 kg (832 g) is equivalent to 1.00 L of fuel | 1 |
| Conversion of mass to moles  n(C12H23) = 832 / (12x12.01 + 23x1.008) = 4.973 mol | 1 |
| Recognition of mole ratio  n(CO2) = 12 x n(C12H23) = 59.68 mol | 1 |
| Conversion of moles to mass  m(CO2) = 59.68 x 44.01 = 2626 g (2.63 x 103 g) (2.63 kg) | 1 |
| **-0.5 for wrong molar mass calcs**. Total | 4 |

Carbon emissions, i.e. CO2(g), from the combustion of fuels is an important issue as CO2(g) is a known Greenhouse gas. However other social and economic issues may determine what fuel is actually used.

(f) Briefly describe a social issue which may influence the fuel used in a particular community. (2)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| One mark for each point mentioned up to a maximum of two marks |  |
| Answers may include but are **not** limited to the following:   Using land otherwise needed for food   Land clearing   Loss of biodiversity   * Possible harmful emissions | 1-2 |
| Total | 2 |

(g) Briefly describe an economic issue which may influence the fuel used in a particular community. (2)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| One mark for each point mentioned up to a maximum of two marks |  |
| Answers may include but are **not** limited to the following:   Cost of production   Cost of transport   Cost of biofuel compared to fossil fuel   * Car modifications required | 1-2 |
| Total | 2 |

(h) Briefly describe a political issue which may influence the fuel used in a particular community. (2)

|  |  |
| --- | --- |
| **Description** | **Marks** |
| One mark for each point mentioned up to a maximum of two marks |  |
| Answers may include but are **not** limited to the following:  Inclusion in worldwide targets   Tax concessions for using specific fuels   Development of programs and initiatives   * Legislation | 1-2 |
| Total | 2 |

**Some students repeated what was mentioned in the question regarding emission of greenhouse gases being an issue. If elaborations were not made then marks were not awarded.  
  
  
  
  
End of questions**