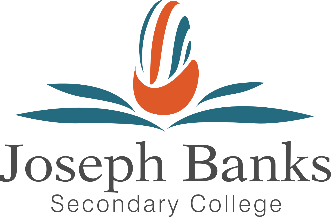
****

**Year 12 Integrated Science General 2020**

TASK 06: SIS -Chemistry

*Comparing the heat energy produced by combustion of various alcohols*

**Background Information**

Alcohol is a homologous series in which the compounds contain a functional group called the hydroxyl group (-OH). The general molecular formula for alcohols is CnH2n+1OH. Alcohols are all derivatives of hydrocarbons in which one or more of the hydrogen atoms in the hydrocarbon have been replaced by a hydroxyl group. The hydroxyl group is also responsible for imparting certain chemical and/or physical properties to the compound. The four most common alcohols, which are also the simplest, are methanol (CH3OH), ethanol(C2H5OH), propanol (C3H7OH) and butanol (C4H9OH).

Alcohols completely combust in the presence of oxygen to form carbon dioxide and water. This reaction produces heat energy that can be measured when conducted under controlled conditions.

**Task Details**

Your task is to complete an investigation in class that compares the amount of heat energy produced by different alcohols. You are required to produce a scientific report of your finding, based on the requirements set out below.

Time allowed for completion of the task:

* Four Lessons of class time dedicated to completing the investigation report
* A device (ipad/laptop) may be used to access research material on Seqta and on the internet.

Class allocated time: Term 3, Week 5/6 (4 lessons)

Task Due Date: 31st August Monday (Term 3, Week 7)

Weighting: 10%

**Useful Documents**

Use your notes from prior classwork, lessons and the following internet resources to answer the knowledge-based questions for this assessment.

The Chemistry of Petrol and Diesel

<https://www.compoundchem.com/2016/05/17/petrol/>

Fuel Properties Comparison

<https://afdc.energy.gov/fuels/properties>

Hydrocarbons in Fossil Fuels

<http://chemistry.elmhurst.edu/vchembook/509fossilfuel.html>

<https://www.intechopen.com/books/diesel-and-gasoline-engines/fuels-of-the-diesel-gasoline-engines-and-their-properties>

**Marking Guide**

|  |  |
| --- | --- |
| **DESCRIPTION** | **MARKS AVAILABLE** |
| **Introduction**  Investigation Aim  Use correct scientific terminology to accurately describe the aim of the investigation using specific examples.   |  |  |  | | --- | --- | --- | | Clear and concise aim, that uses correct language conventions to identify the aim of the investigation using specific scientific terminology | 2 | 2 | | Satisfactory aim that adequately identifies the aim of the investigation, but lacks clear scientific terminology. | 1 |   Hypothesis  Formulate a testable hypothesis that clearly states the relationship between dependent and independent variables.   |  |  |  | | --- | --- | --- | | Clear and concise aim, that uses correct language conventions to identify the aim of the investigation using specific scientific terminology | 2 | 2 | | Satisfactory aim that adequately identifies the aim of the investigation, but lacks clear scientific terminology. | 1 |   Background Information  Communicate information and concepts logically, using correct scientific language, conventions and representations. You must include the following:   * Create a table that lists the following properties of alcohols & hydrocarbons (methanol, ethanol, propanol, butanol, unleaded, diesel)   + Chemical formula   + Molecular structure   + Density   + Boiling temperature  |  |  | | --- | --- | | Correct chemical formula is provided for all 6 fuel types | 1 | | Correct molecular structure diagram is provided for all 6 fuel types | 1 | | Density is provided for all 6 fuel types | 1 | | Boiling temp is provided for all 6 fuel types | 1 |  * Describe the common combustion reaction for alcohols and provide balanced chemical equations for each alcohol type (methanol, ethanol, propanol, butanol).  |  |  |  | | --- | --- | --- | | Clearly describes the common combustion reaction for alcohol, using correct scientific terminology | 2 | 2 | | Provides a satisfactory description of the common combustion reaction for alcohol, lacks specific scientific terminology | 1 | | Provides correct balanced chemical equation for each alcohol type | 1 | 4 |  * Compare and contrast the similarities and differences in the chemical structure and composition between alcohols and hydrocarbons.  |  |  |  | | --- | --- | --- | | Comprehensively describes the structure of hydrocarbons, explaining the hydrocarbon chain and that for each additional C added, you add 2 H atoms after the initial CH4 formula. Comprehensively describes that alcohols have the final H replaced by an OH. Explains the C to H ratio for both. | 3 | 3 | | A good summary of the sim/diff of hydrocarbons and alcohols, correct terminology, tries to explain the C to H ratio. | 2 | | Provides a satisfactory summary that states that hydrocarbons contain only C & H, while alcohols have one of the H atoms replaced by an OH | 1 |  * Explain why it is important to understand the amount of energy produced by each fuel (methanol, ethanol, propanol, butanol, unleaded, diesel) in relation to where each fuel type is used.  |  |  |  | | --- | --- | --- | | Comprehensively describes the structure of hydrocarbons, explaining the hydrocarbon chain and that for each additional C added, you add 2 H atoms after the initial CH4 formula. Comprehensively describes that alcohols have the final H replaced by an OH. Explains the C to H ratio for both. | 3 | 3 | | A good summary of the sim/diff of hydrocarbons and alcohols, correct terminology, tries to explain the C to H ratio. | 2 | | Provides a satisfactory summary that states that hydrocarbons contain only C & H, while alcohols have one of the H atoms replaced by an OH | 1 | | /2  /2  /4  /6  /3  /3 |
| **Material & Method**  Variables  Correctly identify the independent, dependent and at least 3 control variables (including how and why they will be controlled), including any relevant units.   |  |  |  | | --- | --- | --- | | Correct independent variable | | 1 | | Correct dependent variable | | 1 | | At least 3 correct control variables listed, explaining how and why each will be controlled | 3 | 3 | | 3 control variables listed, explain how each will be controlled, does not explain why | 2 | | Lists 3 control variables, does not explain how and why each will be controlled | 1 | | Includes correct units for all relevant sections | | 1 |   Material Setup  Draw a labelled scientific diagram of the experimental setup   |  |  |  | | --- | --- | --- | | Correctly drawn scientific diagram, including all labels, adequate size/scale | 2 | 2 | | Basic scientific diagram and/or missing some labels and/or inadequate size/scale | 1 |   Safety Considerations  Describe the safe and appropriate laboratory behaviour required for this experiment.  Discuss what the implications could be if these measures are not adhered to.   |  |  |  | | --- | --- | --- | | Comprehensively describes the safe and appropriate lab behaviour for this experiment | 2 | 2 | | Basic description of safe lab behaviour for this experiment | 1 | | Describes the implications if the safety measures are not adhered to | | 1 | | /6  /2  /3 |
| **Results**  Table of Results - Observations  Add your results to the class data table, include a copy of the class results in your report. Table must include relevant title and units.   |  |  |  | | --- | --- | --- | | Relevant title that includes both variables | | 1 | | Correct column headings that include units | | 1 | | All data has been added | 2 | 2 | | Some data is missing | 1 |   Calculations  Show a representation of the calculations that have been used to determine the amount of energy produced by each reaction   |  |  | | --- | --- | | Correctly details the formula for the investigation | 1 | | Details the units for each variable in the calculation | 1 | | Provides an example of one calculation using data from the investigation | 1 |   Table of Averages  Collate your average data from the investigation into a separate table.   |  |  |  | | --- | --- | --- | | Table correctly collates all average data for the investigation, including energy values from calculations | 2 | 2 | | Table collates the averages from the observation table, but does not include the energy values from the calculations | 1 | | All required units are included in column headings | | 1 | | Relevant title that incorporates the variables | | 1 |   Graph of Results  Graphically represent the data into a relevant graph type. Graph must include relevant title, axes labels/unit, incremental scale.   |  |  | | --- | --- | | Relevant title that includes both variables | 1 | | Correct axes labels with correct units | 1 | | Correct graph format (line/column) that matches data type (continuous/discontinuous) | 1 | | Incremental scale that spreads data across the page | 1 | | Correctly plotted data as energy produced per gram | 1 | | /4  /3  /4  /5 |
| **Discussion**  Introduction paragraph  Identify what the investigation was comparing and use your results to rank the fuels in terms of energy produced. Justify your results using the chemical composition of each alcohol.   |  |  |  | | --- | --- | --- | | Uses correct scientific terminology and language conventions to identify what the investigation was comparing | | 1 | | Ranks results in correct order of energy produced, using correct language conventions | | 1 | | Comprehensively justifies ranking using correct scientific concepts | 3 | 3 | | Satisfactory justification of ranking using mostly correct scientific concepts | 2 | | Basic justification of ranking using some correct scientific concepts | 1 |   Scientific Explanation of Results  Provide responses for each of the following questions.  **Energy Loss in Chemical Reactions**  Describe the process where energy is lost in a chemical reaction and how heat can be produced by combustion to cause the temperature of the water to increase.   |  |  |  | | --- | --- | --- | | Comprehensively explains the process of exothermic reactions using correct scientific terminology. | 3 | 3 | | Provides a satisfactory explanation of exothermic reactions using some scientific terminology | 2 | | Provides a basic explanation of exothermic reactions, does not incorporate scientific terminology | 1 | | Uses the particle theory to describe how the temperature of the water is increased due to the combustion reaction taking place below | | 1 |   **Effect of Molecular Size on the Amount of Energy Produced in Combustion Reactions**  Explain the effect that the size of the molecule has on the amount of energy produced in a combustion reaction.   |  |  |  | | --- | --- | --- | | Comprehensively explains that the amount of energy released is dependent on the oxidation state of the carbons, therefore the more hydrogen per carbon, the lower the oxidation state and the more energy that is released. | 3 | 3 | | Describes the amount of energy per gram and relates it to the number of atoms in the chemical formula | 2 | | States the general relationship that the larger the molecule, the more energy that is released from its combustion | 1 |   **Similarities and Difference between Diesel and Unleaded Fuels**  Identify the similarities and differences between diesel and unleaded fuels. Use this information to explain why trucks and 4WD vehicles primarily use diesel, while family cars tend to use unleaded fuels.   |  |  |  | | --- | --- | --- | | Family cars tend to not require the high amount of torque produced by diesel fuel, instead faster acceleration for stop-start journey, and trucks carry heavier loads.  Although their greenhouse gas production is higher than those powered by regular gas, diesel engines are more efficient, so they tend to produce about 10 to 20 percent less pollutants.  Diesel 75% saturated hydrocarbons (primarily paraffins including n, iso, and cycloparaffins), and 25% aromatic hydrocarbons (including naphthalenes and alkylbenzenes). ... Petrol consists of hydrocarbons with between 5 and 12 carbon atoms per molecule but then it is blended for various uses.  **Or similar answer** | 4 | 4 | | Trucks carry heavier loads; diesel enables them to carry less fuel as it produces more energy per gram than unleaded. Although their greenhouse gas production is higher than those powered by regular gas, diesel engines are more efficient, so they tend to produce about 10 to 20 percent less pollutants.  **Or similar answer** | 3 | | Trucks carry heavier loads; diesel enables them to carry less fuel as it produces more energy per gram than unleaded. | 2 | | Trucks carry heavier loads than cars. Diesel provides better mileage, so they can carry less fuel. | 1 |   **Fuel Type and the Environment**  Discuss which fuel type is better for the environment, in terms of the amount of CO2 that is produced.   |  |  |  | | --- | --- | --- | | Unleaded is better, as it has a shorter hydrocarbon chain and as such, produces less CO2 when the same amount of fuel is burnt. E.g. Diesel produces 73 kg of CO2 per 1,000,000 BTU’s, compared to 71 kg for gasoline (students may have different values), but it depends upon the specific hydrocarbon composition of the fuel. (provides specific example of amount produced) | 3 | 3 | | Identifies unleaded as better, as it generally contains hydrocarbons with shorter chains, thus producing less CO2 | 2 | | States that the longer the hydrocarbon chain, the more CO2 released into the atmosphere or just identifies unleaded as the better fuel | 1 | | /5  /4  /3  /4  /3 |
| **Conclusion**  Summarise the investigation results and use evidence to draw conclusions that are related to the hypothesis.   |  |  | | --- | --- | | Summarises the purpose and results of the investigation using appropriate language conventions | 1 | | Discusses if results support hypothesis and why/why not this is the case | 1 | | Concludes the report by stating relationships identified in the investigation | 1 | | /3 |
| **References**  Incorporate in-text referencing (where appropriate) and provide a reference list in correct format (e.g. APA).   |  |  |  | | --- | --- | --- | | Correct use of in-text referencing in most required locations | 2 | 2 | | Some correct use of in-text referencing, however needs to be used more frequently | 1 | | Comprehensive reference list, using correct format (e.g. APA) | 2 | 2 | | Basic reference list using weblinks etc. | 1 | | /4 |
| **TOTAL MARKS** | **/73** |