**Thermochemistry Review**

**Multiple Choice**

*Identify the choice that best completes the statement or answers the question.*

*Use the following information to answer the next \_ questions.*

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| Decaying matter may provide energy directly through combustion or indirectly through decomposition to form methane, which can then be burned.  CH4(g) + 2 O2(g) CO2(g) + 2 H2O(g) |

\_\_\_\_ 1. The burning of methane is an example of an

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| --- | --- |
| a. | exothermic reaction in which carbon is oxidized. |
| b. | exothermic reaction in which carbon is reduced. |
| c. | endothermic reaction in which carbon is oxidized. |
| d. | endothermic reaction in which carbon is reduced. |

\_\_\_\_ 2. The molar enthalpy of combustion for methane is

|  |  |
| --- | --- |
| a. | -560.5 kJ/mol |
| b. | -710.1 kJ/mol |
| c. | -802.3 kJ/mol |
| d. | -951.9 kJ/mol |

\_\_\_\_ 3. An equation that represents an endothermic change is

|  |  |
| --- | --- |
| a. | C2H5OH(l) + 2 O2(g) 2 CO2(g) + 3 H2O(g) |
| b. | 2 C(s) + H2(g)  C2H2(g) |
| c. | C(s) + O2(g)  CO2(g) |
| d. | 2 C(s) + 3 H2(g)  C2H6(g) |

\_\_\_\_ 4. Sulfuric acid is used to dissolve copper ore in many mining operations. Sulfuric acid may be produced on site by burning sulfur and dissolving the products in water. The overall equation for this reaction is

S8(g) + 12 O2(g) + 8 H2O(l)  8 H2SO4(aq) + 4225.6 kJ

In this process, what is the enthalpy of reaction for the production of one mole of sulfuric acid?

|  |  |
| --- | --- |
| a. | +4225.6 kJ |
| b. | +528.2 kJ |
| c. | -528.2 kJ |
| d. | -4225.6 kJ |

\_\_\_\_ 5. Which of the following statements is **false**?

|  |  |
| --- | --- |
| a. | Light energy is converted into chemical energy during photosynthesis. |
| b. | Chemical energy is converted into heat and light energy during the combustion of hydrocarbons. |
| c. | Light energy is converted into chemical energy to produce a firefly’s glow. |
| d. | Chemical energy is converted into electrical energy as a voltaic cell discharges. |

\_\_\_\_ 6.

*Use the following information to answer the next question.*

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| Large amounts of ammonia are used in the production of nitric acid, HNO3(aq). One step in the production of nitric acid is prepresented by the equation  4 NH3(g) + 5 O2(g)  4 NO(g) + 6 H2O(g) |

|  |  |
| --- | --- |
| a. | -105.5 kJ |
| b. | -197.7 kJ |
| c. | -905.6 kJ |
| d. | -1274.4 kJ |

\_\_\_\_ 7. A person who states that “all vehicles are really solar-powered” is implying that

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| --- | --- |
| a. | all current vehicles operate on solar cells. |
| b. | solar energy warms a vehicle’s interior on a sunny day. |
| c. | the energy stored in fossil fuels is a result of photosynthesis. |
| d. | solar energy is the ideal renewable, non-polluting energy source. |

\_\_\_\_ 8. The graph that best describes catalyzed (---) and uncatalyzed (**\_\_\_**) exothermic chemical reactions is

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| --- | --- | --- | --- |
| a. |  | c. |  |
| b. |  | d. |  |

*Use the following information to answer the next \_ questions.*

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| Cancarb Ltd, a company located in Medicine Hat, produces high-quality carbon through the themal decomposition of natural gas. The natural gas is heated in the absence of oxygen to 1300°C in a reaction chamber.  The reaction is represented by the equation CH4(g)  C(s) + 2 H2(g) |

\_\_\_\_ 9. In this decomposition, the

|  |  |
| --- | --- |
| a. | reactants have more potential energy than do the products. |
| b. | products have more potential energy than do the reactants. |
| c. | reactants have more kinetic energy than do the products. |
| d. | products have more kinetic energy than do the reactants. |

\_\_\_\_ 10. The thermal decomposition process extracts only about 50% of the carbon from the natural gas. Some of the remaining carbon reacts to form carbon dioxide when released into the atmosphere. Which of the following statements relating to carbon dioxide is **false**?

|  |  |
| --- | --- |
| a. | Carbon dioxide reacts which moisture in the air to produce carbonic acid. |
| b. | Carbon dioxide absorbs infrared radiation and radiates the energy back toward Earth. |
| c. | Carbon dioxide attacks the ozone layer. |
| d. | Carbon dioxide levels increase with deforestation. |

\_\_\_\_ 11. Thermax, C(s), is commonly used as a metallurgical reducing agent. Its reaction with chromium is represented by the **unbalanced** equation

\_\_Cr2O3(s) + \_\_C(s)  \_\_Cr(s) + \_\_CO2(g)

The production of 2.00 mol of Cr(s)

|  |  |
| --- | --- |
| a. | releases 549.5 kJ |
| b. | requires 549.5 kJ |
| c. | releases 1098.9 kJ |
| d. | requires 1098.9 kJ |

*Use the following information to answer the next question.*

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\_\_\_\_ 12. The ∆H for the combustion reaction is

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| --- | --- |
| a. | -951.9 kJ |
| b. | +951.9 kJ |
| c. | -802.3 kJ |
| d. | +802.3 kJ |

*Use the following information to answer the next \_ questions.*

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| Novacor is a large international company that produces ethene (C2H4(g)) from ethane (C2H6(g)) at its plant near Joffre, Alberta. The essential process in the conversion of ethane to ethene is called cracking, which involves the removal of hydrogen atoms from ethane molecules. The cracking occurs in special alloy pipes at temperatures 1 100°C. The process results in the formation of ethene and other byproducts. |

\_\_\_\_ 13. When 10.0 g of ethane gas was originally formed from its elements, the decrease in enthalpy was

|  |  |
| --- | --- |
| a. | 3.92 kJ |
| b. | 28.2 kJ |
| c. | 84.7 kJ |
| d. | 255 kJ |

\_\_\_\_ 14. One of the byproducts of the cracking process used at Novacor is ethyne (C2H2(g)). In the presence of a palladium catalyst, the ethyne forms ethene and ethane. This reaction is represented by the unbalanced equation

C2H2(g) + H2(g)  C2H4(g) + C2H6(g) + energy

The energy diagram that represents both the catalyzed (---) and uncatalyzed reactions (**\_\_\_**) is

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| --- | --- | --- | --- |
| a. |  | c. |  |
| b. |  | d. |  |

*Use the following information to answer the next question.*

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| **Statements Regarding Fossil Fuel Use**  I The combustion of these fuels contributes to the greenhouse effect.  II Locating, extracting, and transporting fossil fuels causes environmental damage.  III The energy yield from fossil fuels is low, thus they are poor energy sources.  IV Fossil fuels are a non-renewable resource. |

\_\_\_\_ 15. The statement about fossil fuel use that is **least** accurate is statement

|  |  |
| --- | --- |
| a. | I |
| b. | II |
| c. | III |
| d. | IV |

*Use the following information to answer the next question.*

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| A student made the following four statements about a chemical reaction.  I The reaction is exothermic.  II The reaction has a negative ∆H value.  III  The reaction warms up the surroundings.  IV The enthalpy of the products is greater than that of the reactants. |

\_\_\_\_ 16. Which statement is not consistent with the other three?

|  |  |
| --- | --- |
| a. | I |
| b. | II |
| c. | III |
| d. | IV |

\_\_\_\_ 17. The substance which does **not** have a standard enthalpy of formation of zero is

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| --- | --- |
| a. | CO(g) |
| b. | Co(s) |
| c. | Ca(s) |
| d. | Cf(s) |

\_\_\_\_ 18. When solid ammonium chloride, NH4Cl(s), is added to water, the solution feels cooler to the touch. The statement which **bests** describes this observation is

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| a. | The dissolving of NH4Cl(s) is exothermic. |
| b. | NH4Cl(s)  NH4+(aq) + Cl−(aq) ∆H = −33.6 kJ |
| c. | Heat is released as NH4Cl(s) dissolves. |
| d. | NH4Cl(s) + 33.6 kJ  NH4+(aq) + Cl−(aq) |

*Use the following information to answer the next question.*

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| C(s) + 2 H2(g)  CH4(g) ∆H = −74.8 kJ  C(s) + 2 Cl2(g)  CCl4(l)  ∆H = −106.4 kJ  H2(g) +  Cl2(g)  HCl(g)  ∆H = −92.3 kJ |

\_\_\_\_ 19. The enthalpy change for the reaction CH4(g) + 4 Cl2(g)  CCl4(l) + 4 HCl(g) is

|  |  |
| --- | --- |
| a. | -123.9 kJ |
| b. | -216.2 kJ |
| c. | -273.5 kJ |
| d. | -400.8 kJ |

*Use the following information to answer the next question.*

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| 6 CO2(g) + 6 H2O(l) + 2802.7 kJ  C6H12O6(s) + 6 O2(g) |

\_\_\_\_ 20. The amount of CO2(g) required to absorb 2.2 x 103 kJ is

|  |  |
| --- | --- |
| a. | 7.6 mol |
| b. | 6.0 mol |
| c. | 4.7 mol |
| d. | 1.3 mol |

\_\_\_\_ 21. A substance has a molar enthalpy of combustion of −810.4 kJ/mol. When 0.285 mol of the substance is burned in a calorimeter containing 8.60 kg of water, the increase in water temperature is

|  |  |
| --- | --- |
| a. | 0.156°C |
| b. | 6.41°C |
| c. | 7.89°C |
| d. | 12.8°C |

*Use the following information to answer the next question.*

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| 3 H2(g) + 2 C(s) + O2(g)  C2H5OH(l) + 227.1 kJ  3 H2(g) + 2 C(s)  C2H6(g) + 84.7 kJ |

\_\_\_\_ 22. The diagram that represents the reaction C2H6(g) +  O2(g)  C2H5OH(l) is

|  |  |  |  |
| --- | --- | --- | --- |
| a. |  | c. |  |
| b. |  | d. |  |

*Use the following information to answer the next \_ questions.*

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| Ethanol is the alcohol found in beer, wine, and whiskey. In the production of ethanol, the starch in barley, grapes, or corn is reacted to form glucose in the presence of enzymes. During the fermentation process, yeast is added to the glucose. The yeast contains enzymes that act as biological catalysts in the reaction of glucose into ethanol and carbon dioxide. The reaction may be represented by the equation  C6H12O6(s)  2 CO2(g) + 2 C2H5OH(l) |

\_\_\_\_ 23. In industry, ethanol is produced by a catalyzed reaction between ethene and water. The equation and energy associated with this reaction can be represented as

|  |  |
| --- | --- |
| a. | C2H4(g) + H2O(l)  C2H5OH(l) + 88.2 kJ |
| b. | C2H4(g) + H2O(l) + 44.2 kJ C2H5OH(l) |
| c. | C2H4(g) + H2O(l)  C2H5OH(l) ∆H = + 88.2 kJ |
| d. | C2H4(g) + H2O(l)  C2H5OH(l) ∆H = − 44.2 kJ |

*Use the following information to answer the next question.*

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| When you drink alcoholic beverages, only 5% of the alcohol is removed through functions such as breathing and sweating. Your liver is responsible for eliminating the other 95%. The alcohol reacts with NAD+(aq), a substance present in the liver. The reaction is catalyzed by an enzyme called alcohol dehydrogenase and the equation can be represented as  C2H5OH(aq) + NAD+(aq)  CH3CHO(aq) + NADH(aq) + H+(aq) + energy |

\_\_\_\_ 24. If you had a low level of the biological catalyst, alcohol dedydrogenase,

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| --- | --- |
| a. | you would feel hotter than normal. |
| b. | the concentration of NADH(aq) would increase. |
| c. | your blood alcohol level would decrease at a faster rate than normal. |
| d. | your blood alcohol level would remain high for a longer period than normal. |

\_\_\_\_ 25. When phosphorus, P4(s), is exposed to air, it ignites spontaneously and rapidly releases 2 940 kJ/mol. Which of the following potential energy diagrams best represents this reaction?

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| --- | --- | --- | --- |
| a. |  | c. |  |
| b. |  | d. |  |

*Use the following information to answer the next \_ questions.*

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| Fuel cells used to power electric vehicles are high-efficiency voltaic cells that consume conventional fuels under conditions of controlled combustion. The half reactions that occur in a propane-oxygen fuel cell are  O2(g) + 4 H+(aq) + 4 e−  2 H2O(l)  C3H8(g) + 6 H2O(l)  3 CO2(g) + 20 H+(aq) + 20 e− |

\_\_\_\_ 26. The balanced net equation and the predicted energy released per mole of propane consumed for this fuel cell are, respectively,

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| a. | C3H8(g) + 5 O2(g)  3 CO2(g) + 4 H2O(l) ∆H = −2 219.9 kJ |
| b. | C3H8(g) + 5 O2(g)  3 CO2(g) + 4 H2O(l) ∆H = −103.8 kJ |
| c. | C3H8(g) + 5 O2(g)  3 CO2(g) + 4 H2O(l) ∆H = −2 043.9 kJ |
| d. | C3H8(g) + O2(g) + 4 H2O(l)  3 CO2(g) + 16 H+(aq) +16 e- ∆H = +66.5 kJ |

\_\_\_\_ 27.

*Use the following additional information to answer the next question.*

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| During the operation of a propane-oxygen fuel cell, 15.7 g of gas are consumed at the anode. |

|  |  |
| --- | --- |
| a. | 9.98 mol |
| b. | 0.693 mol |
| c. | 0.491 mol |
| d. | 0.356 mol |

\_\_\_\_ 28. The combustion of propane and cellular respiration are similar processes. The reactions that occur in both processes are

|  |  |
| --- | --- |
| a. | exothermic, and carbon is reduced. |
| b. | exothermic, and carbon is oxidized. |
| c. | endothermic, and carbon is reduced. |
| d. | endothermic, and carbon is oxidized. |

\_\_\_\_ 29. The substance in the propane-oxygen fuel cell that has a standard enthalpy of formation of zero is

|  |  |
| --- | --- |
| a. | O2(g) |
| b. | CO2(g) |
| c. | H2O(l) |
| d. | C3H8(g) |

\_\_\_\_ 30. Many scientists believe that the most significant problem caused by CO2(g) emissions is

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| a. | metal corrosion. |
| b. | the biomagnification of toxins. |
| c. | the destruction of the ozone layer. |
| d. | its contribution to the greenhouse effect. |

*Use the following information to answer the next \_ questions.*

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| HeaterMeals are “Meals with a Stove Inside.” The stove, or “Food Heater” consists of a water pouch, salt (NaCl(s)), iron, and magnesium. When water is added to the foam tray, the salt dissolves and a chemical reaction occurs, which heats the meal. |

\_\_\_\_ 31. The energy needed to heat the meal is **most likely** produced by a reaction between

|  |  |
| --- | --- |
| a. | Mg(s) and H2O(l) |
| b. | Mg(s) and NaCl(s) |
| c. | Fe(s) and H2O(l) |
| d. | Fe(s) and Mg(s) |

*Use the following additional information to answer the next question.*

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| The chemical reaction that occurs in HeaterMeal raises the temperature of the 100 g of water in the pouch form 23.4°C to 71.7°C. |

\_\_\_\_32. The amount of energy released by the HeaterMeal was

|  |  |
| --- | --- |
| a. | 4.83 kJ |
| b. | 9.71 kJ |
| c. | 9.81 kJ |
| d. | 20.2 kJ |

\_\_\_\_ 33. Which of the following statements describes the chemical reaction that raised the temperature of the water?

|  |  |
| --- | --- |
| a. | An endothermic chemical reaction, which absorbs energy and increases the potential energy of the water, occurred. |
| b. | An endothermic chemical reaction, which absorbs energy and increases the kinetic energy of the water, occurred. |
| c. | An exothermic chemical reaction, which releases energy and increases the potential energy of the water, occurred. |
| d. | An exothermic chemical reaction, which releases energy and increases the kinetic energy of the water, occurred. |

\_\_\_\_ 34. From a technological perspective, the purpose of using a foam tray is to

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| --- | --- |
| a. | increase the specific heat capacity of the solution |
| b. | provide a catalyst for the chemical reaction |
| c. | reduce heat lost to the environment |
| d. | reduce potential landfill waste |

*Use the following information to answer the next question.*

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| Dr. Richard Trotter has developed what could be the first cost-effective process for limiting methane emissions from underground coal mines. In this process, methane and oxygen are reacted at 800°C in the presence of a catalyst. The products of this process are carbon dioxide gas and liquid water. |

\_\_\_\_ 35. Which of the following potential energy diagrams represents both the catalyzed (---) and uncatalyzed (\_\_\_) reactions for this process?

|  |  |  |  |
| --- | --- | --- | --- |
| a. |  | c. |  |
| b. |  | d. |  |

*Use the following information to answer the next \_ questions.*

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| Scuba divers who want to observe sharks will often use a rebreather, which is a self-contained breathing device. A rebreather allows divers to spend a longer time under water and prevents the release of exhaled bubbles that could scare away sharks. Potassium superoxide, KO2(s), ia used in some rebreathers to remove carbon dioxide from exhaled air. The equation for this reaction is shown below.  4 KO2(s) + 2 CO2(g)  2 K2CO3(s) + 3 O2(g)  ∆ *f* H° of KO2(s) = −284.9 kJ/mol  ∆ *f* H° of K2CO3(s) = −1 152.7 kJ/mol |

\_\_\_\_ 36. Which of the following rows identifies the type of reaction represented above and the type of ?H value?

|  |  |  |
| --- | --- | --- |
| **Row** | **Type of Reaction** | **∆H Value** |
| **A.** | Exothermic | Negative |
| **B.** | Exothermic | Positive |
| **C.** | Endothermic | Negative |
| **D.** | Endothermic | Positive |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| a. |  | b. |  | c. |  | d. |  |

\_\_\_\_ 37. The energy transferred when 1 mol of carbon dioxide reacts is

|  |  |
| --- | --- |
| a. | 189.4 kJ |
| b. | 237.2 kJ |
| c. | 378.8 kJ |
| d. | 474.3 kJ |

*Use the following information to answer the next \_ questions.*

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| **Equations**  **1**  C8H18(l) +  O2(g)  8 CO2(g) + 9 H2O(g) + 5 074.1 kJ  **2** C3H8(g) + 5 O2(g)  3 CO2(g) + 4 H2O(g) + 2 043.1 kJ  **3** C2H5OH(l) + 3 O2(g)  2 CO2(g) + 3 H2O(g) + 1 234.8 kJ  **4**  CH4(g) + 2 O2(g)  CO2(g) + 2 H2O(g) + 802.5 kJ |

\_\_\_\_ 38. The original source of energy for the reactants in the four reactions represented by the equations above is

|  |  |
| --- | --- |
| a. | the sun |
| b. | a fossil fuel |
| c. | a combustion reaction |
| d. | a decomposition reaction |

*Use the following information to answer the next \_ questions.*

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| Alfred Nobel was the first person to patent a process to commercially produce dynamite. Dynamite contains nitroglycerine, C3H5(NO3)3(l), an explosive compound that when absorbed by a support material, becomes safer to handle and transport. Nitroglycerine can undergo an explosive decomposition, as represented by the equation  4 C3H5(NO3)3(l)  12 CO2(g) + 10 H2O(g) + 6 N2(g) + O2(g) |

\_\_\_\_ 39. In the decomposition equation, the product species that would have an enthalpy of formation of zero are

|  |  |
| --- | --- |
| a. | carbon dioxide and water vapour |
| b. | water vapour and nitrogen |
| c. | nitrogen and carbon dioxide |
| d. | nitrogen and oxygen |

\_\_\_\_ 40. Reactions producing carbon dioxide cause concern among environmentalists because CO2(g) is

|  |  |
| --- | --- |
| a. | a poisonous gas |
| b. | a major greenhouse gas |
| c. | a major contributor to acid rain |
| d. | an important component of combustion |

*Use the following information to answer the next question.*

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| Tho oil that Syncrude mines from the Athabasca Tar Sands contains large amounts of undesirable sulfur. To remove most of the sulfur, Syncrude uses a chemcial process known as the Claus process, which results in a low-sulfur “sweet” crude oil. Two steps involved in Claus process are shown below.  **Step I** H2S(g) +  O2(g)  SO2(g) + H2O(g) ∆H = − 518 kJ  **Step II** SO2(g) + 2 H2S(g)  3 S(l) + 2 H2O(g) ∆H = − 93 kJ  Syncrude solidifies and stores approximately 1.36 Gg of sulfur per day. |

\_\_\_\_ 41. The net equation and the enthalpy of the reaction for the Claus process are

|  |  |
| --- | --- |
| a. | 3 H2S(g) +  O2(g) 3 S(l) + 3 H2O(g) ∆H = +425 kJ |
| b. | 3 H2S(g) +  O2(g) 3 S(l) + 3 H2O(g) ∆H = − 611 kJ |
| c. | 3 H2S(g) +  O2(g) 3 S(l) + 3 H2O(g) ∆H = −704 kJ |
| d. | 2 H2S(g) + O2(g) 2 S(l) + 2 H2O(g) ∆H = −425 kJ |

\_\_\_\_ 42. When one mole of sodium bicarbonate is formed from its elements, 947.7kJ of energy is released into the surroundings. This enthalpy change can be represented as

|  |  |
| --- | --- |
| a. | Na(s) +  H2(g) + C(s) +  O2(g)  NaHCO3(s) + 947.7 kJ |
| b. | Na(s) +  H2(g) + C(s) +  O2(g) + 947.7 kJ  NaHCO3(s) |
| c. | Na+(aq) + HCO3-(aq)  NaHCO3(s) + 947.7 kJ |
| d. | Na+(aq) + HCO3-(aq) + 947.7 kJ  NaHCO3(s) |

*Use the following information to answer the next \_ questions.*

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| Glucose is a biological fuel used by cells to satisfy the energy needs of plants and animals. The overall reaction for the metabolism of glucose is represented by the **unbalanced** equation  \_\_C6H12O6(s) + \_\_O2(g)  \_\_CO2(g) + \_\_H2O(l) |

\_\_\_\_ 43. The balanced equation and the enthalpy change for the cellular respiration of glucose can be represented as

|  |  |
| --- | --- |
| a. | C6H12O6(s) + O2(g)  CO2(g) + H2O(l) + 593.8 kJ |
| b. | C6H12O6(s) +6 O2(g) + 2 802.7 kJ  6 CO2(g) + 6 H2O(l) |
| c. | C6H12O6(s) +6 O2(g)  6 CO2(g) + 6 H2O(l) + 2 802.7 kJ |
| d. | C6H12O6(s) +6 O2(g)  6 CO2(g) + 6 H2O(l) + 2 538.7 kJ |

\_\_\_\_ 44. If solid glucose is completely burned in the flame of a Bunsen burner, the enthalpy change is

|  |  |
| --- | --- |
| a. | greater than it is during cellular repiration because the production of H2O(g) releases more energy than does the production of H2O(l) |
| b. | less than it is during cellular repiration because the production of H2O(g) releases less energy than does the production of H2O(l) |
| c. | the same as it is in the body because the enthalpy change is independent of the state of the products |
| d. | the same as it is in cellular respiration because they are identical processes |

\_\_\_\_ 45. When 1.65 g of ethanal (CH3CHO(l)) is burned in a calorimeter to produce H2O(l) and CO2(g), 44.7 kJ of heat energy is produced. According to this experimental data, the molar enthalpy of combustion of ethanal is

|  |  |
| --- | --- |
| a. | +1.52 x 103 kJ/mol |
| b. | -76.6 kJ/mol |
| c. | -165 kJ/mol |
| d. | -1.19 x 103 kJ/mol |

*Use the following information to answer the next question.*

|  |
| --- |
| Many insects and small animals have unique defense systems. Bombardier beetles fight off predators with a hot chemical spray. The spray consists of solutions of hydroquinone (C6H4(OH)2(aq)), hydrogen peroxide (H2O2(aq)), and enzymes, which are secreted by the beetles’ glands.  **Bombardier Beetle**    **Related Equations Related to Spray Formation**  **I** 2 H2O(l) + O2(g)  2 H2O2(aq) ∆H = +189.2 kJ  **II** H2O(l)  H2(g) +  O2(g) ∆H = +285.8 kJ  **III** C6H4(OH)2(aq)  C6H4O2(aq) + H2(g) ∆H = +177.0 kJ  A chemical reaction that occurs in order to produce the hot chemical spray can be represented by the equation  C6H4(OH)2(aq) + H2O2(aq)  C6H4O2(aq) + 2 H2O(l) |

\_\_\_\_ 46. The enthalpy of reaction for the production of this hot chemical spray is

|  |  |
| --- | --- |
| a. | − 489.2 kJ |
| b. | − 203.4 kJ |
| c. | − 82.4 kJ |
| d. | +12.2 kJ |

*Use the following information to answer the next 2 questions.*

|  |
| --- |
| Commercially available “cold packs” and “hot packs” contain an inner pouch of a solid ionic compound within an outer pouch containing water. When the inner pouch is broken, the solid dissolves in the water of the outer pouch. When ammonium nitrate dissolves, the water temperature decreases; whereas, when calcium chloride dissolves, the water temperature increases. |

\_\_\_\_ 47. Based on this information, a student determined that a hot pack could contain

|  |  |
| --- | --- |
| a. | calcium chloride, which undergoes an exothermic dissolving process |
| b. | calcium chloride, which undergoes an enodthermic dissolving process |
| c. | ammonium nitrate, which undergoes an exothermic dissolving process |
| d. | ammonium nitrate, which undergoes an endothermic dissolving process |

\_\_\_\_ 48. Which of the following diagrams represents the enthalpy of solution for either a cold pack or a hot pack?

|  |  |  |  |
| --- | --- | --- | --- |
| a. |  | c. |  |
| b. |  | d. |  |

*Use the following information to answer the next question.*

|  |
| --- |
| A student comparing cellular respiration and hydrocarbon combustion reactions make the following statements.  **I** In both reactions, C-H bond break and C=O bonds form.  **II** Combustion is exothermic and cellular respiration is endothermic.  **III** Both reactions are examples of redox reactions. |

\_\_\_\_ 49. The student’s correct statements were

|  |  |
| --- | --- |
| a. | I and II |
| b. | I and III |
| c. | II and III |
| d. | I, II, and III |

*Use the following information to answer the next question.*

|  |
| --- |
| **Standard Enthalpies of Formation**  **Substance ∆ *f* H° (kJ/mol)**  X −22.5  Y +78.3  Z −54.8  Given: X + 3 Y  2 Z + 2 W ∆H = −562.0 kJ |

\_\_\_\_ 50. The standard molar enthalpy of formation of substance W is

|  |  |
| --- | --- |
| a. | +442.0 kJ/mol |
| b. | − 120.0 kJ/mol |
| c. | − 240.0 kJ/mol |
| d. | − 451.4 kJ/mol |

*Use the following information to answer the next \_ questions.*

|  |
| --- |
| Ethanol, C2H5OH(l), is a very versatile compound that has applications in the fuel, chemical, and pharmaceutical industries. Some properties of ethanol can be studied in the lab by applying thermodynamic properties.  A student assembled the apparatus shown below in order to determine the molar enthalpy of combustion of ethanol. |

\_\_\_\_ 51. The balanced equation and the appropriate enthalpy change for the combustion of ethanol are

|  |  |
| --- | --- |
| a. | C2H5OH(l) + 3 O2(g)  2 CO2(g) + 3 H2O(g) ∆H = +1235.3 kJ |
| b. | C2H5OH(l) + O2(g)  CO2(g) + 3 H2O(g) ∆H = − 1235.3 kJ |
| c. | C2H5OH(l) + 3 O2(g)  2 CO2(g) + 3 H2O(g) ∆H = − 1235.3 kJ |
| d. | C2H5OH(l)  C(s) + O2(g) + 3 H2(g) ∆H = +1235.3 kJ |

\_\_\_\_ 52. The thermochemical equation that represents the molar enthalpy of formation for ethanol is

|  |  |
| --- | --- |
| a. | C2H5OH(l) + 277.1 kJ  2 C(s) + 3 H2(g) +  O2(g) |
| b. | C2H5OH(l) + 3 O2(g) 2 CO2(s) + 3 H2O(g) + 1 235.3 kJ |
| c. | 2 C(s) + 3 H2(g) +  O2(g) C2H5OH(l) + 277.1 kJ |
| d. | C2H5OH(l) + H2O(l) C2H5O−(aq) + H3O+(aq) K = 1.3 x 10-16 |

\_\_\_\_ 53. In a chemistry experiment, 12 g of (NH4)2SO4(s) was dissolved in 120 mL of water in a simple calorimeter. A temperature change from 20.2°C to 17.8°C was observed. The experimental molar enthalpy of solution for ammonium sulfate was

|  |  |
| --- | --- |
| a. | - 13 kJ/mol |
| b. | - 1.2 kJ/mol |
| c. | +1.2 kJ/mol |
| d. | +13 kJ/mol |

\_\_\_\_ 54. The heat energy produced when 1.00 g of butane in a disposable lighter is completely burned to form gaseous carbon dioxide and water vapour is

|  |  |
| --- | --- |
| a. | 45.7 kJ |
| b. | 124.7 kJ |
| c. | 2 656.5 kJ |
| d. | 5 313.0 kJ |

\_\_\_\_ 55. The reason that dynamite releases a great amount of heat energy when it explodes is that the

|  |  |
| --- | --- |
| a. | products have more potential energy than the reactants in this endothermic reaction |
| b. | reactants have more potential energy than the products in this endothermic reaction |
| c. | products have more potential energy than the reactants in this exothermic reaction |
| d. | reactants have more potential energy than the products in this exothermic reaction |

*Use the following equations to answer the next question.*

|  |
| --- |
| **I** H2(g) +  O2(g)  H2O(g) H = -241.8 kJ  **II**  N2(g) +  O2(g) + 90.2 kJ  NO(g)  **III** C(s) +  O2(g)  CO(g) + 110.5 kJ  **IV**   H2(g) +  I2(s)  HI(g) H = +26.5 kJ |

\_\_\_\_ 56. Which of these equations represent exothermic reactions?

|  |  |
| --- | --- |
| a. | I and II |
| b. | I and III |
| c. | II and IV |
| d. | III and IV |

*Use the following reactions to answer the next question.*

|  |
| --- |
| **Glucose Reactions**  **I** C6H12O6(aq) + 6 O2(g)  6 H2O(l) + 6 CO2(g)  **II** C6H12O6(s) + 6 O2(g)  6 H2O(g) + 6 CO2(g) |

\_\_\_\_ 57. Which of the following statements describes the reactions above?

|  |  |
| --- | --- |
| a. | Carbon is reduced in both reactions. |
| b. | Both reactions are endothermic. |
| c. | Reaction I could be classified as cellular respiration and reaction II could be classified as combustion. |
| d. | The state of water produced makes no difference when the enthalpy of reaction is calculated. |

\_\_\_\_ 58. The molar enthalpy of solution for NaOH(s) is -44.6 kJ/mol. If 25.0 g of NaOH(s) is dissolved in water in a calorimeter, the heat released inside the calorimeter is

|  |  |
| --- | --- |
| a. | 27.9 kJ |
| b. | 71.4 kJ |
| c. | 1.12 MJ |
| d. | 1.78 MJ |

\_\_\_\_ 59. When 24.0 g of carbon and 10.0 g are placed in a calorimeter and reacted according to the equation 3 C(s) + 4 H2(g)  C3H8(g) + 103.8 kJ, the maximum amount of heat liberated by this reaction is

|  |  |
| --- | --- |
| a. | 69.1 kJ |
| b. | 128 kJ |
| c. | 257 kJ |
| d. | 619 kJ |

*Use the following diagram to answer the next question.*

|  |
| --- |
| **Potential Energy Diagram** |

\_\_\_\_ 60. The potential energy change for this reaction is

|  |  |
| --- | --- |
| a. | +170 kJ |
| b. | +90 kJ |
| c. | - 80 kJ |
| d. | - 170 kJ |

*Use the following information to answer the next question.*

|  |
| --- |
| One component of acid rain can be formed in the atmosphere by the reaction  SO3(g) + H2O(l)  H2SO4(aq) + 227.8 kJ |

\_\_\_\_ 61. The molar enthalpy of formation of H2SO4(aq) in the atmosphere, under standard conditions, is

|  |  |
| --- | --- |
| a. | - 453.7 kJ/mol |
| b. | - 586.7 kJ/mol |
| c. | - 814.0 kJ/mol |
| d. | - 906.8 kJ/mol |

*Use the following information to answer the next question.*

|  |
| --- |
| Al4C3(s) + 12 H2O(l)  4 Al(OH)3(s) + 3 CH4(g) ∆H = - 1763.0 kJ |

\_\_\_\_ 62. If this equation is rewritten to show the production of one mole of CH4(g) and the energy is expressed as a term in the equation, then the energy will be

|  |  |
| --- | --- |
| a. | 587.7 kJ on the reactant side |
| b. | 1763.0 on the reactant side |
| c. | 587.7 on the product side |
| d. | 1763.0 on the reactant side |

*Use the following information to answer the next question.*

|  |
| --- |
| The reaction W  W can proceed directly or through a series of steps as shown. |

\_\_\_\_ 63. The diagram illustrates

|  |  |
| --- | --- |
| a. | the Law of Conservation of Mass |
| b. | an exothermic reaction |
| c. | an endothermic reaction |
| d. | Hess’s Law |

*Use the following information to answer the next 3 questions.*

|  |
| --- |
| The Sun is the original source of energy stored in fossil fuels. Energy transformations affect the quality of life on the planet. Burning fosil fuels increases levels of atomospheric carbon dioxide, which contributes to the greenhouse effect. |

\_\_\_\_ 64. The molar enthalpy of combustion for propane, assuming gaseous products are formed, is

|  |  |
| --- | --- |
| a. | -2251.5 kJ/mol |
| b. | -2219.9 kJ/mol |
| c. | -2043.9 kJ/mol |
| d. | -103.8 kJ/mol |

\_\_\_\_ 65. The combustion of hydrogen gas as an automobile fuel is an attractive alternative to the combustion of fossil fuels because

|  |  |
| --- | --- |
| a. | the fuel tank for hydrogen would be smaller |
| b. | burning hydrogen gas forms non-polluting products |
| c. | hydrogen gas is less expensive and is readily available for use |
| d. | the molar enthalpy of combustion for hydrogen gas is greater than those of the hydrocarbon fuels |

\_\_\_\_ 66. Which of the following substances contained in automobile exhaust is also produced in cellular respiration?

|  |  |
| --- | --- |
| a. | H2O |
| b. | SO2 |
| c. | unburned hydrocarbons |
| d. | nitrogen oxide compounds |

*Use the following information to answer the next three questions.*

|  |
| --- |
| **Fuel Molar Enthalpy of Combustion**    methane - 802.3 kJ/mol  butane  - 2656.5 kJ/mol  octane - 5074.2 kJ/mol  ethyne  - 1255.5 kJ/mol |

\_\_\_\_ 67. An interpretation from the table is that, the greater the number of covalent bonds in a fossil fuel molecule, the

|  |  |
| --- | --- |
| a. | lower the energy stored in the molecule |
| b. | greater the energy released on combustion |
| c. | lower the moles of oxygen required for complete combustion |
| d. | greater the strength of each covalent bond |

\_\_\_\_ 68. Which of the following fuels produces the greatest amount of energy per mole of carbon dioxide produced?

|  |  |
| --- | --- |
| a. | methane |
| b. | butane |
| c. | octane |
| d. | ethyne |

*Use this additional information to answer the next question.*

|  |
| --- |
| CH3OH(l) +  O2(g)  CO2(g) + 2 H2O(g) ∆H = - 638.1 kJ |

\_\_\_\_ 69. One possible explanation for the fact that less energy is released in the combustion of methanol than in the combustion of methane is that methane has

|  |  |
| --- | --- |
| a. | less potential energy than methanol |
| b. | more potential energy than methanol |
| c. | more kinetic energy than methanol |
| d. | less kinetic energy than methanol |

*Use the following information to answer the next question.*

|  |
| --- |
| Scientists have proposed that the burning of methane involves the following four-step reaction pathway.  **Step 1** CH4(g) +  O2(g)  CH3OH(l) ∆H = - 164.2 kJ  **Step 2** CH3OH(l) + O2(g)  CH2O(g) + H2O(g) ∆H = - 118.7 kJ  **Step 3** CH2O(g) + O2(g)  HCOOH(g) ∆H = - 308.8 kJ  **Step 4** HCOOH(g) + O2(g)  CO2(g) + H2O(g) ∆H = - 210.6 kJ |

\_\_\_\_ 70. Assuming that all the graphs are drawn to the same scale, the graph that best represents the reaction pathway for the burning of methane is

|  |  |  |  |
| --- | --- | --- | --- |
| a. |  | c. |  |
| b. |  | d. |  |

*Use the following information to answer the next question.*

|  |
| --- |
| 2 C(s) + 2 H2(g) +  O2(g)  CH3CHO(l) + 191.5 kJ  CH3CO(l) +  O2(g)  2 CO2(g) + 2 H2O(g) + 1079.1 kJ |

\_\_\_\_ 71. The molar enthalpy of formation for ethanal, CH3CHO(l), is

|  |  |
| --- | --- |
| a. | +1079.1 kJ/mol |
| b. | +191.5 kJ/mol |
| c. | - 191.5 kJ/mol |
| d. | - 1079.1 kJ/mol |

*Use the following information to answer the next \_ questions.*

|  |
| --- |
| Nitrogen gas, a stable component of air, reacts with oxygen at high temperatures to produce nitrogen oxides. The energy produced by the combustion of fossil fuels is sufficient to promote the formation of the nitrogen oxides.  N2(g) + 2 O2(g) + 66.4 kJ  2 NO2(g)  These oxides react with moisture in the air to produce components of acid rain. |

\_\_\_\_ 72. The equation indicates that the reaction

|  |  |
| --- | --- |
| a. | is exothermic |
| b. | is endothermic |
| c. | is releasing energy |
| d. | products have less energy than do the reactants |

*Use the following information to answer the next question.*

|  |
| --- |
| S8(s) + O2(g)  SO2(g) ∆H = − 296.8 kJ  S8(s) +  O2(g)  SO3(g) ∆H = − 395.7 kJ |

\_\_\_\_ 73. The enthalpy of reaction for SO2(g) +  O2(g)  SO3(g) is

|  |  |
| --- | --- |
| a. | - 98.0 kJ |
| b. | - 692.5 kJ |
| c. | +98.9 kJ |
| d. | +692.5 kJ |

*Use the following information to answer the next question.*

|  |
| --- |
| 4 HNO3(aq) + 5 N2H4(l)  7 N2(g) + 12 H2O(g) ∆H = - 2462.0 kJ |

\_\_\_\_ 74. Which statement is correct for the reaction above?

|  |  |
| --- | --- |
| a. | 205.2 kJ are absorbed per mole of H2O(g) used. |
| b. | 351.7 kJ are absorbed per mole N2(g) formed. |
| c. | 615.5 kJ are released per mole of HNO3(aq) used. |
| d. | 492.4 kJ are released per mole of N2H4(l) formed. |

\_\_\_\_ 75. The enthalpy of reaction for the complete combustion of methanal according to the equation

CH2O(g) + O2(g)  CO2(g) + H2O(l) is

|  |  |
| --- | --- |
| a. | - 787.9 kJ |
| b. | - 570.7 kJ |
| c. | - 526.7 kJ |
| d. | - 440.1 kJ |

\_\_\_\_ 76. The molar enthalpy of combustion for ethylene glycol, C2H4(OH)2(l), is - 1181.2 kJ/mol when the products of combustion are gaseous. The molar enthalpy of formation of ethylene glycol is

|  |  |
| --- | --- |
| a. | +590.6 kJ/mol |
| b. | - 331.2 kJ/mol |
| c. | - 500.7 kJ/mol |
| d. | - 1181.2 kJ/mol |

*Use the following information to answer the next \_ questions.*

|  |
| --- |
| In 1999, the Breitling Orbiter 3 became the first balloon to circumnavigate the world. The air in the balloon was heated by the combustion of propane, which can be represented by the equation  C3H8(g) + 5 O2(g)  3 CO2(g) + 4 H2O(g) |

\_\_\_\_ 77. The molar enthalpy of combustion of propane for the reaction shown in the equation above is

|  |  |
| --- | --- |
| a. | -103.8 kJ/mol |
| b. | -2 043.9 kJ/mol |
| c. | -2 219.9 kJ/mol |
| d. | -2 251.5 kJ/mol |

**Numeric Response**

*Use the following information to answer the next \_ questions.*

|  |
| --- |
| Decaying matter may provide energy directly through combustion or indirectly through decomposition to form methane, which can then be burned.  CH4(g) + 2 O2(g) CO2(g) + 2 H2O(g) |

78. A mid-efficiency gas furnace distributes 78.0% of the energy available from burning methane. The amount of energy distributed for heating a home when 12.5 mol of CH4(g) burns in the furnace is

\_\_\_\_\_\_\_ MJ.

*(Record your three digit answer in the numeric response section.)*

*Use the following information to answer the next question.*

|  |  |
| --- | --- |
| **Equations**  H(g) + Br(g)  HBr(g) + 366 kJ  H(g) + F(g)  HF(g) + 565 kJ  H(g) + I(g)  HI(g) + 299 kJ  H(g) + Cl(g)  HCl(g) + 431 kJ | **Key**  **1** HBr(g)  **2** HF(g)  **3** HI(g)  **4** HCl(g) |

79. When the hydrogen-halide bond strengths are ordered from strongest to weakest, the order is \_\_, \_\_, \_\_, \_\_.

*(Record your four digit answer in the numeric response section.)*

*Use the following information to answer the next \_ questions.*

|  |
| --- |
| Cancarb Ltd, a company located in Medicine Hat, produces high-quality carbon through the themal decomposition of natural gas. The natural gas is heated in the absence of oxygen to 1300°C in a reaction chamber.  The reaction is represented by the equation  CH4(g)  C(s) + 2 H2(g) |

80. The energy required to completely decompose 1.00 mol of methane into carbon and hydrogen under standard conditions is \_\_\_\_\_ kJ.

*(Record your three digit answer in the numeric response section.)*

*Use the following information to answer the next question.*

|  |
| --- |
| At high temperatures, nitrogen and oxygen react to form nitrogen oxides.  **Reaction I**  N2(g) +  O2(g)  NO(g) ∆ *f* H°= +90.2 kJ  **Reaction II** N2(g) + O2(g)  NO2(g) ∆ *f*H° = +33.2 kJ  The reddish-brown colour of smog is a result of a reaction between NO(g) and O2(g) to produce NO2(g). |

81. The energy released by the reaction NO(g) +  O2(g)  NO2(g) is \_\_\_\_\_\_\_\_ kJ.

*(Record your three digit answer in the numeric response section.)*

*Use the following information to answer the next question.*

|  |
| --- |
| **1** absorbed **5** potential  **2** released **6** kinetic  **3** intermolecular **7** endothermic  **4**  intramolecular **8** exothermic |

82. *Use the numbers from the terms listed above to complete these statements.*

During the process of photosynthesis, energy is \_\_\_\_\_\_\_\_\_ and used to rearrange \_\_\_\_\_\_\_\_\_\_\_ bonds. This results in an increase in \_\_\_\_\_\_\_\_\_\_ energy. During cellular respiration or combustion, the stored energy is released in a/an \_\_\_\_\_\_\_\_\_\_\_ process.

*(Record your four digit answer in the numeric response section.)*

*Use the following information to answer the next question.*

|  |
| --- |
| C2H4(g)  H2(g) + C2H2(g) |

83. The ∆H for this reaction is \_\_\_\_\_\_\_\_\_ x 102 kJ.

*(Record your three digit answer in the numeric response section.)*

*Use the following information to answer the next question.*

|  |
| --- |
| A(s) + 2 BC(aq)  AC2(aq) + B2(g) ∆H = +35.2 kJ  AD(s) + 2 BC(aq)  AC2(aq) + B2D(l) ∆H = +8.3 kJ  B2(g) +  D2(g)  B2D(l) ∆H = +22.4 kJ |

84. The ∆H for the reaction A(s) +  D2(g)  AD(s) is +/-\_\_\_\_\_\_ kJ.

*(Record your three digit answer in the numeric response section).*

*Use the following information to answer the next \_ questions.*

|  |
| --- |
| Ethanol is the alcohol found in beer, wine, and whiskey. In the production of ethanol, the starch in barley, grapes, or corn is reacted to form glucose in the presence of enzymes. During the fermentation process, yeast is added to the glucose. The yeast contains enzymes that act as biological catalysts in the reaction of glucose into ethanol and carbon dioxide. The reaction may be represented by the equation  C6H12O6(s)  2 CO2(g) + 2 C2H5OH(l) |

85. The molar enthalpy of reaction for the fermentation of glucose is +/- \_\_\_\_\_ kJ/mol.

*(Record your three digit answer in the numeric response section.)*

*Use the following information to answer the next question.*

|  |
| --- |
| The energy from cellular respiration is stored in the form of ATP (adenosine triphosphate) molecules in cells. As energy is required by a cell, it is released from ATP molecules as they react to form ADP (adenosine diphosphate) molecules. The reaction may be represented by the equilibrium equation ATP(aq)  ADP(aq) + PO43−(aq) + 30.5 kJ  Cells contain large numbers of ADP and ATP molecules. |

86. When you are reading, you use 400 kJ/h of energy. In one hour, the number of moles of ATP reacted to form ADP is \_\_\_\_\_\_\_\_ mol.

*(Record your three digit answer in the numeric response section.)*

*Use the following graph to answer the next question.*

|  |
| --- |
| **Enthalpy of Formation for BaO2(s)** |

87. According to the information shown above and in the data booklet, the ∆H of reaction for BaO(s) +  O2(g)  BaO2(s) is +/-\_\_\_\_\_kJ.

*(Record your three digit answer in the numeric response section.)*

88. In organisms, the reaction of sucrose and oxygen produces carbon dioxide, water and energy. The energy available may be estimated using the reaction for the combustion of sucrose:

C12H22O11(aq) + 12 O2(g)  12 CO2(g) + 11 H2O(l) + 5 640.3 kJ

The quantity of energy available when 1.00 g of sucrose reacts is \_\_\_\_\_ kJ.

*(Record your three digit answer in the numeric response section.)*

*Use the following information to answer the next \_ questions.*

|  |
| --- |
| **Equations**  **1**  C8H18(l) +  O2(g)  8 CO2(g) + 9 H2O(g) + 5 074.1 kJ  **2** C3H8(g) + 5 O2(g)  3 CO2(g) + 4 H2O(g) + 2 043.1 kJ  **3** C2H5OH(l) + 3 O2(g)  2 CO2(g) + 3 H2O(g) + 1 234.8 kJ  **4**  CH4(g) + 2 O2(g)  CO2(g) + 2 H2O(g) + 802.5 kJ |

89. When ranked in order from the reaction that has the **smallest** enthalpy change per mole of carbon dioxide to the reaction that has the **largest** enthalpy change per mole of carbon dioxide gas, the reactions are \_\_, \_\_, \_\_, and \_\_.

*(Record your four digit answer in the numeric response section.)*

*Use the following information to answer the next question.*

|  |
| --- |
| The following diagram illustrates the formation enthalpies of V(s), Cl2(g), and a selection of their compounds.  **Formation Enthalpies of Vanadium Chlorides** |

90. The amount of energy absorbed when 0.350 mol of VCl4(l) decomposes to form VCl2(s) and Cl2(g) is \_\_\_\_\_\_\_ kJ.

*(Record your three digit answer in the numeric response section.)*

91. The energy released when 1.00 mol of AgI(s) is formed from its elements is \_\_\_\_\_\_\_\_ kJ.

*(Record your three digit answer in the numeric response section.)*

*Use the following information to answer the next question.*

|  |
| --- |
| 2 C2H2(g) + 5 O2(g)  4 CO2(g) + 2 H2O(g) ∆H = −2 511.0 kJ |

92. The amount of energy released by the combustion of 100 g of C2H2(g) is \_\_\_\_\_\_\_\_\_ MJ.

*(Record your three digit answer in the numeric response section.)*

*Use the following information to answer the next \_ questions.*

|  |
| --- |
| Ethanol, C2H5OH(l), is a very versatile compound that has applications in the fuel, chemical, and pharmaceutical industries. Some properties of ethanol can be studied in the lab by applying thermodynamic properties.  A student assembled the apparatus shown below in order to determine the molar enthalpy of combustion of ethanol. |

|  |
| --- |
| **Calorimetric Data**  **1**  maximum temperature change of water  **2** mass of aluminium calorimeter  **3** mass of aluminium calorimeter and water  **4** initial temperature of aluminium calorimeter  **5** maximum temperature change of ethanol  **6** mass change of ethanol |

93. The data required to determine the molar enthalpy of combustion for ethanol, listed in numerical order, are \_\_\_, \_\_\_, \_\_\_, and \_\_\_.

*(Record your four digit answer in the numeric response section.)*

94. In an experiment, a student heated 500 g of water from 25.0°C to 91.0°C using 0.133 mol of ethanol. If it assumed that all the heat energy was absorbed by the calorimeter and water, the experimental molar enthalpy of combustion for ethanol was +/- \_\_\_\_\_\_\_\_\_ MJ/mol.

*(Record your three digit answer in the numeric response section.)*

*Use the following information to answer the next question.*

|  |
| --- |
| **1** biological decay **3** energy from the Sun  **2** photosynthesis **4** combustion |

95. From the formation of fossil fuels to their eventual use as automobile fuel, the sequence of the above steps, is \_\_\_, \_\_\_, \_\_\_, and \_\_\_.*(Record your four digit answer in the numeric response section.)*

*Use the following information to answer the next \_ questions.*

|  |
| --- |
| Nitrogen gas, a stable component of air, reacts with oxygen at high temperatures to produce nitrogen oxides. The energy produced by the combustion of fossil fuels is sufficient to promote the formation of the nitrogen oxides.  N2(g) + 2 O2(g) + 66.4 kJ  2 NO2(g)  These oxides react with moisture in the air to produce components of acid rain. |

96. The amount of energy involved when one mole of nitrogen dioxide is formed is \_\_\_\_\_\_\_\_ kJ.

*(Record your three digit answer in the numeric response section.)*

97. Given the reaction

CaC2(s) +  O2(g)  CaCO3(s) + CO2(g) ∆H = −1537.5 kJ,

the enthalpy of formation of CaC2(s) is − \_\_\_\_\_\_\_\_\_ kJ/mol.

*(Record your three digit answer in the numeric response section.)*

*Use the following information to answer the next question.*

|  |
| --- |
| **1** methane **5** ethyne  **2** ethene **6**  nitrogen dioxide  **3** benzene **7**  butane  **4** methanol **8** octane |

98. The compounds that require energy during formation from their constituent elements, listed in numeric order, are \_\_\_, \_\_\_, \_\_\_, and \_\_\_.

*(Record your four digit answer in the numeric response section.)*

*Use the following information to answer the next \_ questions.*

|  |
| --- |
| In 1999, the Breitling Orbiter 3 became the first balloon to circumnavigate the world. The air in the balloon was heated by the combustion of propane, which can be represented by the equation C3H8(g) + 5 O2(g)  3 CO2(g) + 4 H2O(g) |

99. The amount of energy required to heat the air in the balloon to flight temperature and initiate flight is 1.00 x 108 kJ. The mass of propane required to heat this air is \_\_\_\_\_\_Mg.

*(Record your three digit answer in the numeric response section.)*

*Use the following information to answer the next question.*

|  |
| --- |
| A thermite reaction is a highly exothermic process that is used in welding massive steel objects such a ship propellers and train rails. The reaction can be represented by the equation  2 Al(s) + Fe2O3(s)  Al2O3(s) + 2 Fe(s) ∆H = −851.5 kJ |

100. If the heat produced by the reaction of 1.00 mol of iron(III) oxide were absorbed by 7.40 kg of H2O(l) at room temperature, then the resulting temperature change of the water would be \_\_\_\_\_\_\_\_°C.

*(Record your three digit answer in the numeric response section.)*

**Short Answer**

101. A student wished to determine whether fats or sugars had the higher energy content. Small samples of stearic acid, C18H36O2(s) (a fatty acid) or sucrose, C12H22O11(s) (a sugar) were burned and the data collected as shown below.

|  |
| --- |
| Sucrose Stearic Acid  Mass of sample 1.55 g 1.17 g  Calorimeter constant (heat capacity) 8.57 kJ/°C 8.57 kJ/°C  Initial temperature of calorimeter 24.30°C 26.40°C  Final temperature of calorimeter 27.88°C 30.28°C |

a. Use the data collected to calculate the enthalpy of combustion for 1.00 g of each substance. *(4 marks)*

b. The student decided that a diet should consist of food with the highest energy content. Based on your calculations, which foods would be better in the student’s diet. Explain. *(3 marks)*

c. Identify one problem/concern with the diet proposed in part **b**. *(1 mark)*

Communication *(2 marks)*

102. *Use the following information to answer the next question.*

|  |
| --- |
| The above apparatus was used to determine experimentally the molar enthalpy of the combustion of candle wax, C25H52(s). |

1a. List all the measurements that must be taken in order to determine the molar

enthalpy of combustion. *(4 marks)*

1b. Write a mathematical equation that uses the data collected and that will allow you

to determine the molar enthalpy of combustion. Label each of the mathematical

variables used in the equation. *(2 marks)*

1c. Suggest two improvements to the experimental design. *(2 marks)*

103. *Use the following information to answer the next question.*

|  |
| --- |
| Hydrogen gas that is used by fuel cells to make electricity can be produced by a variety of methods. Simplified representations of some of these methods are shown by the equations below. **Methods for Producing Hydrogen Gas**  **1** C3H8(g) + 6 H2O(g)  3 CO2(g) + 10 H2(g)  **2** C(s) + 2 H2O(g)  CO2(g) + 2 H2(g)  **3** 2 H2O(l)  O2(g) + 2 H2(g) |

**Compare** the amount of energy that each method requires to produce hydrogen gas. **Identify** the method that would require the **least** amount of energy to produce hydrogen gas and include support for your choice.

Your explanation should include

• molar enthalpy calculations in kJ/mol of H2(g) produced for each method

• a potential energy diagram that represents the energy change that occurs in the

reaction represented by the method that you identified

• an environmental or economic benefit that is associated with the method that

you identified

104. *Use the following information to answer the next question.*

|  |
| --- |
| Outdoor equipment manufacturer Mountain Safety Research of Seattle, Washington, manufactures a camping stove called the XGK Expedition Stove.  The XGK can burn liquid fuels such as white gas, kerosene diesel, naphtha, stoddard solvent, and gasoline. |

**Design** an experiment that would allow you to choose the best fuel for heating an aluminium pot filled with water on the XGK stove.

Your response should also include

• a detailed procedure

• the identity of all relevant variables

• another consideration for choosing a fuel

105. *Use the following information to answer the next question.*

|  |
| --- |
| A space shuttle uses more than one type of rocket fuel. The two solid rocket boosters use a fuel mixture of aluminium and ammonium perchlorate (together they form the solid fuel) that reacts according to the equation  3 Al(s) + 3 NH4ClO4(s)  Al2O3(s) + 3 NO(g) + 6 H2O(g)  In the three main shuttle engines, a mixture of hydrogen and oxygen form a second fuel. The hydrogen and oxygen are carried as compressed liquids in a large tank adjoining the shuttle and react to produce energy according to the reaction  H2(g) +  O2(g)  H2O(g)    **Relevant Enthalpies of Formation**  ∆fH° of NH4ClO4(s) = −295.3 kJ/mol  ∆fH° of AlCl3(s) = −705.6 kJ/mol |

Compare the two rocket fuels as energy sources for powering the space shuttle.

Your response should also include

• the calculated energy released for each fuel

• an analysis of the energy to mass ratio (kJ/g) for each fuel

• an environmental concern or benefit related to each fuel

106. *Use the following information to answer the next question.*

|  |
| --- |
| The uranium-235 isotope is used as a fuel in some nuclear power plants. This isotope is used to enrich natural uranium ore. Prior to the enrichment process, the uranium ore, UO2(s), is converted to UF6(s). This conversion is represented by the following sequential equations.  **Equation I** UO2(s) + 4 HF(g)  UF4(s) + 2 H2O(g)  **Equation II** UF4(s) + F2(g)  UF6(s)  **Relevant Molar Enthalpies of Formation**  **Substance ∆fH° (kJ/mol)**  UO2(s) − 1129.7  UF4(s) − 1914.0  UF6(s) − 2112.9 |

a. Use molar enthalpies of formation to calculate the amount of heat energy involved in producing 2.00 Mg of UF6(s) from natural uranium ore, UO2(s).

*(4 marks)*

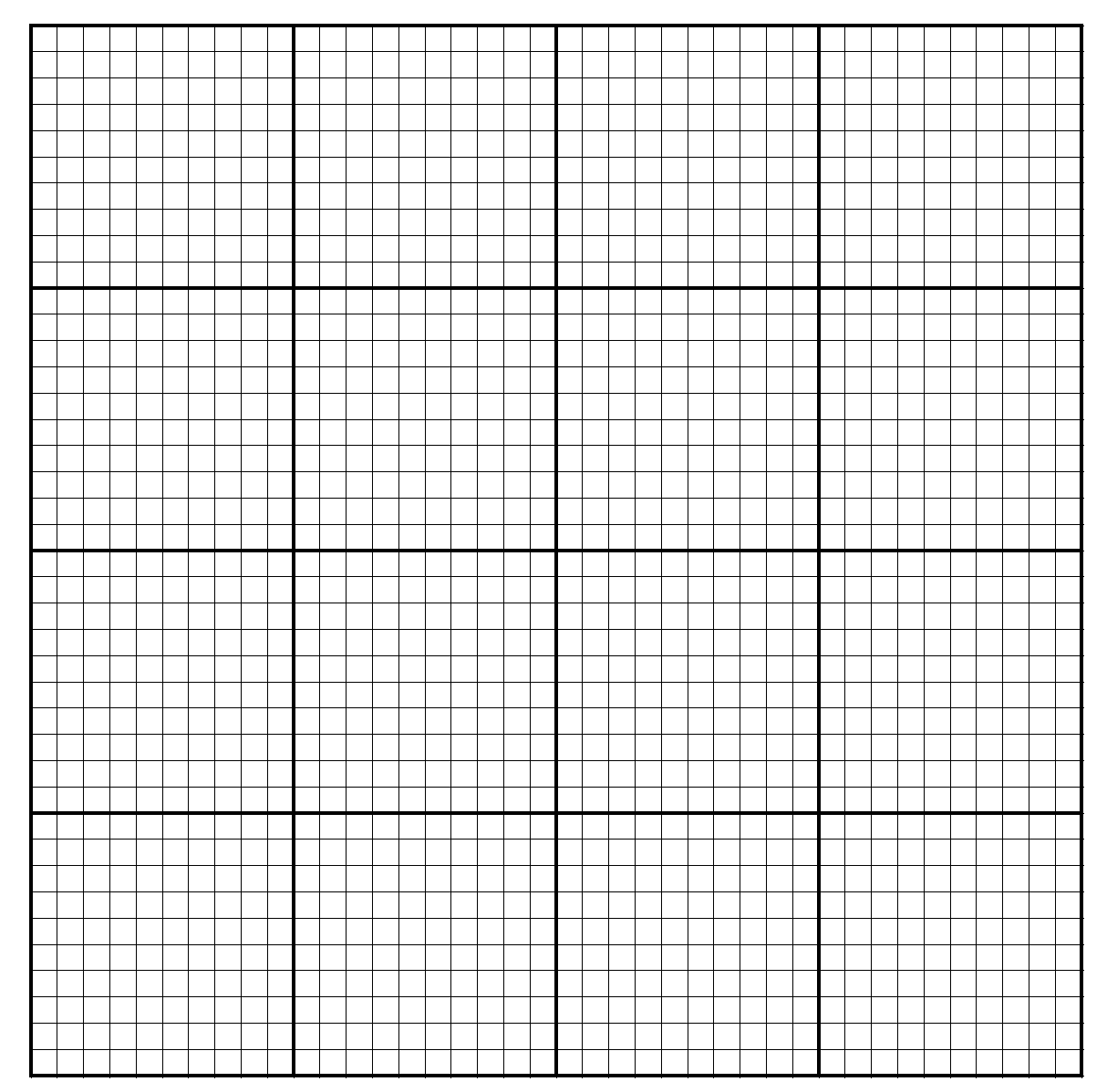
b. Evaluate the use of nuclear energy for the generation of electricity. Include two reasons for and two reasons against the use of nuclear energy. *(4 marks)*

107. The combustion of sugar in a calorimeter is similar to the oxidation of sugar in the body. A student ate three sugar cubes, with masses of 6.84 g, 6.75 g and 6.79 g.

a. Calculate the overall molar enthalpy of oxidation of sugar, C12H22O11(s), in the body. *(3 marks)*

b. Using these three sugar cubes as representative of regular-sized cubes, determine the amount of energy released by an average-sized cube. *(3 marks)*

c. Draw and label a potential energy diagram representing the molar enthalpy of oxidation of sugar in the body. *(2 marks)*



Communication *(2 marks)*

**Thermochemistry Review**

**Answer Section**

**MULTIPLE CHOICE**

1. ANS: A PTS: 1 REF: June 1997 Diploma

OBJ: 30-A1.1k TOP: thermodynamics KEY: methane combustion

2. ANS: C PTS: 1 REF: June 1997 Diploma

OBJ: 30-A1.7k TOP: thermodynamics KEY: enthalpy calculation

3. ANS: B PTS: 1 REF: June 1997 Diploma

OBJ: 30-A1.6k TOP: equations KEY: enthalpy change

4. ANS: C PTS: 1 REF: June 1997 Diploma

OBJ: 30-A1.4k TOP: equations KEY: molar enthalpy

5. ANS: C PTS: 1 REF: June 1997 Diploma

OBJ: 30-A1.10k TOP: thermodynamics KEY: energy change

6. ANS: C PTS: 1 REF: June 1997 Diploma

OBJ: 30-A1.7k TOP: thermodynamics KEY: Hess calculation

7. ANS: C PTS: 1 REF: June 1998 Diploma

OBJ: 30-A1.2k TOP: energy KEY: original source of energy

8. ANS: D PTS: 1 REF: June 1998 Diploma

OBJ: 30-A1.3s TOP: potential energy diagrams KEY: catalyzed vs uncatalyzed

9. ANS: B PTS: 1 REF: June 1998 Diploma

OBJ: 30-A1.6k TOP: exothermic reaction KEY: enthalpy of decomposition

10. ANS: C PTS: 1 REF: June 1998 Diploma

OBJ: 30-A2.2sts TOP: environmental KEY: effects of carbon dioxide

11. ANS: D PTS: 1 REF: June 1998 Diploma

OBJ: 30-A1.6k TOP: enthalpy change KEY: calculation from ∆H formation

12. ANS: C PTS: 1 REF: June 1998 Diploma

OBJ: 30-A1.3s TOP: enthalpy change KEY: ∆H from a potential energy diagram

13. ANS: B PTS: 1 REF: January 2000 Diploma

OBJ: 30-A1.6k TOP: enthalpy change KEY: calculation of ∆H from a mass

14. ANS: C PTS: 1 REF: January 2000 Diploma

OBJ: 30-A2.2k TOP: ?H diagram KEY: catalyzed vs uncatalyzed reaction

15. ANS: C PTS: 1 REF: January 2000 Diploma

OBJ: 30-A2.2sts TOP: fossil fuel use KEY: risks and benefits

16. ANS: D PTS: 1 REF: January 2000 Diploma

OBJ: 30-A1.10k TOP: changes in enthalpy

KEY: description of an exothermic reaction

17. ANS: A PTS: 1 REF: June 1991 Diploma

OBJ: 30-A1.3k TOP: enthalpy of reaction KEY: ∆H formation of elements

18. ANS: D PTS: 1 REF: June 1991 Diploma

OBJ: 30-A1.5k TOP: enthalpy changes KEY: describing an endothermic reactions

19. ANS: D PTS: 1 REF: June 1991 Diploma

OBJ: 30-A1.7k TOP: Hess's Law KEY: series of reactions

20. ANS: C PTS: 1 REF: June 1991 Diploma

OBJ: 30-A1.3s TOP: enthalpy change

KEY: predicting the amount of reactant given the ∆H

21. ANS: B PTS: 1 REF: June 1992 Diploma

OBJ: 30-A1.8k TOP: calorimetry KEY: calculating ∆t

22. ANS: C PTS: 1 REF: June 1992 Diploma

OBJ: 30-A1.3s TOP: Hess's Law KEY: energy diagrams

23. ANS: D PTS: 1 REF: January 2000 Diploma

OBJ: 30-A1.5k, 30-A1.7k TOP: Hess's Law KEY: calculation and energy term

24. ANS: D PTS: 1 REF: January 2000 Diploma

OBJ: 30-A2.4k TOP: enzyme catalysis KEY: predicting results

25. ANS: C PTS: 1 REF: June 2000 Diploma

OBJ: 30-A1.3s TOP: potential energy diagrams KEY: estimated ∆H

26. ANS: A PTS: 1 REF: June 2000 Diploma

OBJ: 30-A1.7k TOP: Hess's Law KEY: calculation using ∆H formation

27. ANS: D PTS: 1 REF: June 2000 Diploma

OBJ: 30-A1.2sts TOP: stoich problem KEY: calculation of mol

28. ANS: B PTS: 1 REF: June 2000 Diploma

OBJ: 30-A1.10k TOP: exothermic KEY: combustion and respiration

29. ANS: A PTS: 1 REF: June 2000 Diploma

OBJ: 30-A1.6k TOP: enthalpy of formation KEY: elements

30. ANS: D PTS: 1 REF: June 2000 Diploma

OBJ: 30-A2.3sts TOP: fuel consumption KEY: greenhouse effect

31. ANS: A PTS: 1 REF: 2003 Released Items

OBJ: 30-A1.6k TOP: ∆H KEY: predicting from a table

32. ANS: D PTS: 1 REF: 2003 Released Items

OBJ: 30-A1.8k TOP: ∆H calculation KEY: mc?t of water

33. ANS: D PTS: 1 REF: 2003 Released Items

OBJ: 30-A1.10k TOP: ?H KEY: description from calorimetry information

34. ANS: C PTS: 1 REF: 2003 Released Items

OBJ: 30-A1.2sts TOP: STS KEY: insulation of foam tray

35. ANS: B PTS: 1 REF: 2004 Released Items

OBJ: 30-A2.2k TOP: potential energy diagrams KEY: catalyzed vs uncatalyzed

36. ANS: A PTS: 1 REF: 2006 Released Items

OBJ: 30-A1.7k TOP: Hess's Law KEY: calculation and classification

37. ANS: A PTS: 1 REF: 2006 Released Items

OBJ: 30-A1.7k TOP: Hess's Law KEY: calculation of ?H when given a reactant

38. ANS: A PTS: 1 REF: 2007 Released Items

OBJ: 30-A1.2k TOP: combustion energy KEY: original source

39. ANS: D PTS: 1 REF: January 2002 Diploma

OBJ: 30-A1.6k TOP: ∆H of formation KEY: elements

40. ANS: B PTS: 1 REF: January 2002 Diploma

OBJ: 30-A2.2sts TOP: carbon dioxide emissions KEY: greenhouse gases

41. ANS: B PTS: 1 REF: January 2002 Diploma

OBJ: 30-A1.7k TOP: Hess's Law KEY: net equation and enthalpy

42. ANS: A PTS: 1 REF: June 2001 Diploma

OBJ: 30-A1.4k TOP: chemical equations KEY: energy as a term

43. ANS: C PTS: 1 REF: June 2001 Diploma

OBJ: 30-A1.4k TOP: respiration KEY: equation and energy term

44. ANS: B PTS: 1 REF: June 2001 Diploma

OBJ: 30-A1.9k TOP: enthalpy changes KEY: combustion vs respiration

45. ANS: D PTS: 1 REF: June 2001 Diploma

OBJ: 30-A1.8k TOP: ?H KEY: calorimetry data

46. ANS: B PTS: 1 REF: June 2001 Diploma

OBJ: 30-A1.7k TOP: ∆H KEY: enthalpy from a series of reactions

47. ANS: A PTS: 1 REF: January 2001 Diploma

OBJ: 30-A1.8k TOP: ∆H solution KEY: chemical suitable for a hot pack

48. ANS: A PTS: 1 REF: January 2001 Diploma

OBJ: 30-A1.3s TOP: potential energy diagrams KEY: endothermic reaction

49. ANS: B PTS: 1 REF: January 2001 Diploma

OBJ: 30-A1.10k TOP: reactions KEY: comparing combustion to cellular respiration

50. ANS: B PTS: 1 REF: January 2001 Diploma

OBJ: 30-A1.7k TOP: ∆H of formation KEY: calculation from ∆H

51. ANS: C PTS: 1 REF: January 2001 Diploma

OBJ: 30-A1.5k TOP: ethanol combustion KEY: equation and ∆H

52. ANS: C PTS: 1 REF: January 2001 Diploma

OBJ: 30-A1.4k TOP: enthalpy of formation KEY: equation with energy term

53. ANS: D PTS: 1 REF: January 2001 Diploma

OBJ: 30-A1.8k TOP: ?H of solution KEY: calorimetric data

54. ANS: A PTS: 1 REF: January 2001 Diploma

OBJ: 30-A1.7k TOP: ?H KEY: n?Hr calculation

55. ANS: D PTS: 1 REF: June 1999 Diploma

OBJ: 30-A1.10k TOP: reactions KEY: classify as exo/endothermic

56. ANS: B PTS: 1 REF: June 1999 Diploma

OBJ: 30-A1.10k TOP: equations KEY: classify ∆H and energy terms

57. ANS: C PTS: 1 REF: June 1999 Diploma

OBJ: 30-A1.10k TOP: glucose KEY: combustion vs cellular respiration

58. ANS: A PTS: 1 REF: June 1999 Diploma

OBJ: 30-A1.3k TOP: ?H calculation KEY: n∆Hr

59. ANS: A PTS: 1 REF: June 1999 Diploma

OBJ: 30-A1.3k TOP: ?H calculation KEY: n∆Hr with a limiting reagent

60. ANS: C PTS: 1 REF: June 1999 Diploma

OBJ: 30-A1.3s TOP: potential energy diagram KEY: ∆ in enthalpy

61. ANS: D PTS: 1 REF: June 1999 Diploma

OBJ: 30-A1.6k TOP: Hess's calculation KEY: ?H formation from a reaction

62. ANS: C PTS: 1 REF: January 1999 Diploma

OBJ: 30-A1.4k TOP: enthalpy of reaction KEY: energy as a term in the reaction

63. ANS: D PTS: 1 REF: January 1999 Diploma

OBJ: 30-A1.7k TOP: Hess's KEY: diagrammatic representations

64. ANS: C PTS: 1 REF: January 1998 Diploma

OBJ: 30-A1.6k TOP: Hess's Law KEY: calculation of ∆H combustion

65. ANS: B PTS: 1 REF: January1 1998 Diploma

OBJ: 30-2.2sts TOP: burning fossil fuels KEY: greenhouse effect

66. ANS: A PTS: 1 REF: January 1998 Diploma

OBJ: 30-A1.10k TOP: reactions KEY: combustion vs respiration

67. ANS: B PTS: 1 REF: January 1998 Diploma

OBJ: 30-2.3k TOP: fuels KEY: energy content

68. ANS: A PTS: 1 REF: January 1998 Diploma

OBJ: 30-A2.3sts TOP: fuel KEY: energy per mol carbon dioxide

69. ANS: B PTS: 1 REF: January 1998 Diploma

OBJ: 30-A2.3k TOP: fuel KEY: potential energy

70. ANS: A PTS: 1 REF: January 1998 Diploma

OBJ: 30-2.2k TOP: combustion KEY: potential energy diagrams

71. ANS: C PTS: 1 REF: January 1998 Diploma

OBJ: 30-A1.4k

72. ANS: B PTS: 1 REF: January 1998 Diploma

OBJ: 30-A1.4k

73. ANS: A PTS: 1 REF: January 1998 Diploma

OBJ: 30-A1.7k

74. ANS: C PTS: 1 REF: January 1996 Diploma

OBJ: 30-A1.5k

75. ANS: B PTS: 1 REF: January 1996 Diploma

OBJ: 30-A1.6k

76. ANS: B PTS: 1 REF: January 1994 Diploma

OBJ: 30-A1.6k

77. ANS: B PTS: 1 REF: 2005 Released items

OBJ: 30-A1.7k TOP: Hess's Law KEY: calculation

**NUMERIC RESPONSE**

78. ANS: 7.82 PTS: 1 REF: June 1997 Diploma OBJ: 30-A2.3s

TOP: thermodynamics KEY: efficiency

79. ANS: 2413 PTS: 1 REF: June 1997 Diploma OBJ: 30-A2.3k

TOP: thermodynamics KEY: bond energy

80. ANS: 74.8 PTS: 1 REF: June 1998 Diploma OBJ: 30-A1.6k

TOP: enthalpy change KEY: standard molar enthalpy of decomposition

81. ANS: 57.0 PTS: 1 REF: June 1998 Diploma OBJ: 30-A1.7k

TOP: Hess's Law KEY: calculations from equations

82. ANS: 1458 PTS: 1 REF: June 1998 Diploma OBJ: 30-A1.10k

TOP: energy change KEY: photosynthesis/cellular respiration

83. ANS: 3.11 PTS: 1 REF: June 1992 Diploma OBJ: 30-A1.7k

TOP: Hess's Law KEY: calculating ∆H

84. ANS: 48.3 PTS: 1 REF: June 1992 Diploma OBJ: 30-A1.7k

TOP: Hess's Law KEY: calculation from a series of equations

85. ANS: 68.9 PTS: 1 REF: January 2000 Diploma OBJ: 30-A1.6k

TOP: Hess's Law KEY: calculation given the equation

86. ANS: 13.1 PTS: 1 REF: January 2000 Diploma OBJ: 30-A1.3s

TOP: energy calculation KEY: mol of reactant given the equation

87. ANS: 95.2 PTS: 1 REF: January 2000 Diploma OBJ: 30-A1.3s

TOP: Hess's Law KEY: energy diagram

88. ANS: 16.5 PTS: 1 REF: June 2000 Diploma OBJ: 30-A1.7k

TOP: ∆H calculation KEY: n∆Hr

89. ANS: 3124 PTS: 1 REF: 2007 Released Items OBJ: 30-A1.3s

TOP: enthalpy change KEY: compare per mol carbon dioxide

90. ANS: 41.1 PTS: 1 REF: January 2002 Diploma OBJ: 30-A1.3s

TOP: ∆H calculation KEY: calculation using ?H formation

91. ANS: 61.8 PTS: 1 REF: June 2001 Diploma OBJ: 30-A1.6k

TOP: ∆H of formation KEY: energy released

92. ANS: 4.82 PTS: 1 REF: June 2001 Diploma OBJ: 30-A1.5k

TOP: ∆H KEY: n∆Hr

93. ANS: 1236 PTS: 1 REF: January 2001 Diploma OBJ: 30-A1.8k

TOP: enthalpy of combustion KEY: calorimetric data for calculation

94. ANS: 1.04 PTS: 1 REF: January 2001 Dipolma OBJ: 30-A1.8k

TOP: enthalpy calculation KEY: ∆H combustion from calorimetric data

95. ANS: 3214 PTS: 1 REF: January 1998 Diploma OBJ: 30-A1.2k

TOP: fuels KEY: energy from the Sun

96. ANS: 33.2 PTS: 1 REF: January 1998 Diploma OBJ: 30-A1.3k

97. ANS: 63.6 PTS: 1 REF: January 1998 Diploma OBJ: 30-A1.6k

98. ANS: 2356 PTS: 1 REF: January 1996 Diploma OBJ: 30-A1.5k

99. ANS: 2.16 PTS: 1 REF: 2005 Released items OBJ: 30-A1.5k

TOP: mass of propane KEY: given ?H

100. ANS: 27.5 PTS: 1 REF: 2005 Released items OBJ: 30-A1.1k

TOP: ∆t calculation KEY: given q and m

**SHORT ANSWER**

101. ANS: a. -19.8 kJ/g for sucrose (1 mark for method, one mark for correct answer)

-28.4 kJ/g for stearic acid (1 mark for method, one mark for correct answer)

b. stearic acid (1 mark)

foods with a high fat content such as butter, ice cream etc. (2 marks)

c. condition such as heart disease (1 mark)

PTS: 1 REF: June 1997 Diploma OBJ: 30-A1.8k

TOP: calorimetry data KEY: analytic question

102. ANS: 1a. temperature ? of calorimeter + water (1 mark)

mass ∆ of candle (1 mark)

mass of calorimeter (1 mark)

mass of calorimeter water (1 mark)

1b. n∆Hr = mc∆t(water) + mc∆t(calorimeter) (1 mark)

Label (1 mark)

1c. 1 mark for each improvement

PTS: 1 REF: June 2000 Diploma OBJ: 30-A1.1s

TOP: Calorimetry KEY: investigation, combustion, analytic

103. ANS: Key 2 marks - Hess’s Law calculation for each of the three methods and a

selection of the method with the least amount

Support 1 mark - kJ/mol H2(g) calculation for each method

1 mark - a potential energy diagram with labels

1 mark - an environmental/economic benefit

PTS: 1 REF: January 2007 Diploma OBJ: 30-A1.3s

TOP: energy production KEY: Hess's calculation, potential energy diagram, STS

104. ANS: Key 2 marks - an experiment which tests at least 2 fuels to heat up the water

(may manipulate time, mass of fuel and measure ?t change of water)

Support 1 mark - details of procedure (masses, time, water volume, pot mass)

1 mark - identifying variables consistent with design

1 mark - consideration such as cost, availability etc.

PTS: 1 REF: 2003 Released Items OBJ: 30-A1.1s

TOP: fuel comparison KEY: fuels, camping stove

105. ANS: Key 2 marks - the identification of the best fuel based on their calculations

Supports 1 mark - correct Hess’s calculation for each fuel

1 mark - correct energy to mass calculation

1 mark - concern/benefit associated with each fuel

PTS: 1 REF: January 2002 Diploma OBJ: 30-A2.3sts

TOP: fuel comparison KEY: Hess calculations, kJ/g ratio, environmental

106. ANS: a. 1 mark for a correct balanced equation

1 mark for a correct method

1 mark for a correct substitution

1 mark for a correct answer

b. 1 mark for each reason (2 for and 2 against)

PTS: 1 REF: June 1999 Diploma OBJ: 30-A1.6k, 30-A2.3sts

TOP: Hess's calculation with nuclear KEY: nuclear advantages/disadvantages

107. ANS: a. 1 mark for a balanced equation

1 mark for using Hess’s

1 mark for the correct answer

b. 1 mark for calculating the average

1 mark for using n∆Hr

1 mark for correct ∆H

c. 1 mark for the correct shape

1 mark for labels/title

PTS: 1 REF: January 1999 OBJ: 30-A1.6k, 30-A1.3s

TOP: oxidation of glucose KEY: Hess's, n∆Hr, potential energy diagram