**Unit 5 Free Response & Practicum Review**

*Paraffin wax (C25H52), a hydrocarbon, is the main component of candle wax. Cindy takes a small tea candle and burns it on a piece of aluminum foil for about four minuntes in an effort to determine the amount of heat released when paraffin wax combusts.*

*Use the data to answer the questions that follow:*

|  |  |
| --- | --- |
| Initial mass of candle and Al foil | 42.0 g |
| Final mass of candle and Al foil (after burning) | 39.2 g |
| Mass of paraffin wax used in reaction | **2.80 g** (you can calculate this) |

1. Given that the formula for paraffin wax is *C25H52* , calculate the molar mass of this compound.

**(25 x 12.01) + (52 x 1.01) = 352.77 g/mol**

1. Calculate the number of moles of paraffin wax that were used in the reaction (use the mass of paraffin used in the reaction and convert to moles)

**2.80 g wax x 1 mol wax = 0.00794 mol wax**

**352.77 g**

1. The balanced chemical equation for the combustion of paraffin is as follows:

*C25H52* (s) + 38O2 (s) 🡪 26H2O (g) + 25 CO2 (g)

Using average bond energies, calculate the heat of reaction for **one mole** of paraffin wax. *(Hint: Pariffin wax, C25H52 , contains 24 C-C bonds and 52 C-H bonds)*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Bond | H-H | C-H | C-C | C=C | O-H | C-O | C=O | O=O | O-O |
| Bond energy (kJ/mol) | 452 | 413 | 347 | 614 | 467 | 358 | 799\* | 495 | 146 |

\*C=O in CO2: 799, in organic molecules: 745

**[(24x347)+(52x413) + (38x495)] 🡪 [(26(2x467) + 25(2x799)]**

**48,614 🡪 -64,234**

**-15,620 kJ/mol**

1. Calculate the amount of heat Cindy’s candle released in the reaction (based on the answer for number 3 and the amount of paraffin wax burned in the experiment).

**0.00794 mol wax x -15,620 kJ = -124 kJ heat released**

**1 mol wax**

1. Consider the composition and decomposition of water. When water is formed,

ΔHreaction=-242kJ/mol and when water decomposes, ΔHreaction=+242kJ/mol.

* 1. Write the balanced equations (including heat of reaction as a reactant or product) for the composition and decomosition of water.

**Water formation: 2H2 (g) + O2 (g) 🡪 2H2O (g) + 242 kJ**

**Water Decomposition: 2H2O (g) + 242 kJ 🡪 2H2 (g) + O2 (g)**

* 1. Draw an energy diagram for the composition and decomposition of water. Label the transition states, activation energy, products, reactants, and heat of reaction in each.

**Formation of Water:**

**Transition State**

**Reactants:**

**2H2 + O2**

**Activation Energy**

**-242 kJ/mol**

**Heat of Reaction**

**Product:**

**2H2O**

**Decomposition of Water:**

**Products:**

**2H2 + O2**

**Activation Energy**

**Reactant:**

**2H2O**

**+ 242 kJ/mol**

**Heat of Reaction**

* 1. Which reaction is endothermic? Which is exothermic?

**Decomposition of water is endothermic, Formation of water is exothermic**

1. From the following substances, choose which would make the best fuel and explain why.

Alcohol Noble gas Ionic Compound **Alkane** Covalent Compond

**This will make the best fuel because it will burn with the most kJ/mol because it has the most carbons and fewest oxygens in a combustable compound when compared to alcohols or other covalent compounds. Noble gases or ionic compounds do not combust.**

1. Write the balanced chemical equation for the combustion of the following:
   1. Butonol, C4H10O

**C4H10O + 6O2 🡪 4CO2 + 5H2O**

* 1. Hexanol, C6H14O

**C6H14O + 9O2 🡪 6CO2 + 7H2O**

1. List all the ways you can speed up a chemical reaction.

**Add heat, stir reactants, crush particles (increase surface area of reactants), increase concentration of reactants, increase or decrease pressure, add a catalyst**

1. The two half-cell reactions below can be combined to form an electrochemical cell.

Al3+ + 3e- 🡪 Al -1.71 volts

Pb2+ + 2e- 🡪 Pb -0.13 volts

1. Which metal will be oxidized?

**Lead**

1. What is the voltage of the cell?

**Because lead is oxidized, the reaction and value of voltage is flipped so, to determine voltage of the cell the equation is the absolute value of the sum of -1.71V + 0.13V = 1.58V**

1. Write a balanced chemical equation for the overall reaction in the cell.

**3Pb (s) + 2Al3+ (aq) 🡪 3Pb2+ (aq) + 2Al (s)**

1. The two half-cell reactions below can be combined to form an electrochemical cell.

Mg2+ + 2e- 🡪 Mg -2.38 volts

F33+ + 3e- 🡪 Fe -0.04 volts

1. Which metal will be oxidized?

**Iron**

1. What is the voltage of the cell?

**Because iron is oxidized, the reaction and value of voltage is flipped so, to determine voltage of the cell the equation is the absolute value of the sum of -2.38V + 0.04V = 2.34V**

1. Write a balanced chemical equation for the overall reaction in the cell.

**2Fe (s) + 3Mg2+ (aq) 🡪 2Fe3+ (aq) + 3Mg(s)**

1. Why does a red object appear red to our eyes when white light is shining on it?

**Red is reflected while the other colors of white light are absorbed**

1. Calculate the frequency of purple light that has a wavelength of 4.20 x 10-7m. The speed of light is 3.00 x 108 m/s.

**f= c/λ**

**f = 3.00 x 108 m/s = 7.14 x 1014 Hz**

**4.20 x 10-7 m**

1. Calculate the wavelength of light that has a frequency of 2.30 x 106 Hz. The speed of light is 3.00 x 108 m/s.

**λ = c/f**

**λ = 3.00 x 108 m/s = 130 m**

**2.30 x 106 Hz**

1. Calculate the energy of radiation that has a wavelength of 3.21 x 10-10 m. The speed of light is 3.00 x 108 m/s, and Planck’s constant is 6.626 x 10-34 J•s.

**E = hc/λ**

**E = (6.626 x 10-34 J•s) • (3.00 x 108 m/s) = 6.19 x 10-32 J**

**3.21 x 10-10 m**

1. Calculate the energy of radiation that has a wavelength of 2.5 x 10-12m. The speed of light is 3.00 x 108 m/s, and Planck’s constant is 6.626 x 10-34 J•s.

**E = hc/**λ

**E = (6.626 x 10-34 J**•**s)** • **(3.00 x 108 m/s) = 7.95 x 10-14 J**

**2.5 x 10-12 m**