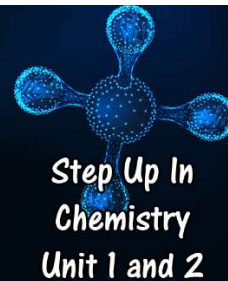# 4.4 Energy Changes and Fuels

Problems Worksheet

1. Describe whether the following processes are likely to be endothermic or exothermic:
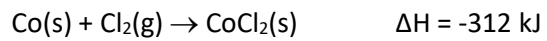   a. Boiling water

   b. Molten lava solidifying

   c. Combining hydrogen and oxygen to form water

   d. Activating an instant cold pack

2. Cobalt metal can react with chlorine gas to produce cobalt chloride:

Co(s) + Cl$_2$(g) → CoCl$_2$(s)   ΔH = -312 kJ
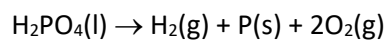
    a. Rewrite the equation with the energy as a term in the equation.

    b. Draw an energy profile diagram for the reaction.

    c. Calculate the amount of energy released when 275 g of cobalt react.

3. If phosphoric acid is decomposed into its constituent elements, energy is absorbed:

$H_2PO_4(l) \rightarrow H_2(g) + P(s) + 2O_2(g)$

a. When 486 g of phosphoric acid reacts, 6306 kJ of energy is required. Calculate change in enthalpy for the reaction in kJ.mol^{-1}.

b. Write a thermochemical equation for the reaction.

c. Draw an energy profile diagram for the reaction.

4. The heat of combustion for methane, ethane and propane are shown in the table:

Fuel	Heat of Combustion (kJ/mol)
Methane	889
Ethane	1560
Propane	2200

Determine the most efficient fuel in terms of:

a. Energy released per kilogram of fuel.

b. The mass of carbon dioxide released per kilojoule of energy produced.

5. Explain the main factors that affect the quality of coal.

6. Biofuels such as bioethanol and biodiesel still release carbon dioxide when they are combusted. Why are these fuels considered better for the environment than fossil fuels?

7. Tristan and Noah are measuring the heat of reaction for metal displacement reactions. They measure 200.0 mL of copper sulfate solution and pour it into a styrofoam cup. They add 3.55 g of powdered zinc metal and record a temperature increase of 11.2 °C as the zinc all dissolves.

   a. Use the formula $Q = mc\Delta T$ to determine the amount of energy absorbed by the solution. Assume the mass of the solution is 200 g and the specific heat capacity (c) of the solution is 3900.0 $J.kJ^{-1}.°C^{-1}$.

   b. Determine the heat of reaction in $kJ.mol^{-1}$ of zinc.

   c. Given that the zinc dissolves in the copper sulfate to produce zinc sulfate and copper metal, write a thermochemical equation for the reaction.

   d. State a likely systematic error in the experiment.