Period 11: Chemical Energy and Fossil Fuels

11.1 What is the Composition of Matter?

1) Atoms
   a) What are the building blocks of an atom?

   b) Which nucleons make up an atomic nucleus?

   c) What holds nucleons together within the nucleus of an atom?

   d) How many electrons does an atom have? How many electrons does an ion have?

   e) What holds electrons in orbit around the nucleus of an atom?

   f) What is an element?

11.2 What are Chemical Reactions?

2) Chemical Compounds Your instructor will discuss chemical compounds.
   a) The formula for acetic acid, which is found in vinegar, is HC₂H₃O₂. Which elements make up acetic acid? How many atoms of each element are contained in one molecule?

3) Chemical Equations
   A chemical equation describes a chemical reaction. A balanced equation has the same number of atoms of each element on either side of the arrow.

   Are the equations given below balanced? If not, write numbers in the blanks before the substances to indicate the number of molecules of each substance needed to balance the equation.
   a) ___H₂ + ___O₂ → ___H₂O
   b) ____CO₂ + ____H₂O → ____C₆H₁₂O₆ + ____O₂
11.3 Energy and Chemical Reactions

4) Endothermic and Exothermic Reactions
   Your instructor will show you examples of exothermic and endothermic reactions. In the first example, we mix acetic acid with sodium carbonate in a plastic bag.
   a) What do you feel when you touch the outside of the plastic bag? ______
   b) Is this reaction endothermic or exothermic? How do you know?

   Next your instructor will mix acetic acid with sodium bicarbonate in another plastic bag.
   c) What do you feel when you touch the outside of this plastic bag? ______
   d) Is this reaction endothermic or exothermic? How do you know?

   e) Activate a reusable commercial hot pack. Since the hot pack emits thermal energy, what must be done to the pack before it can be reused?

   f) Activate a commercial cold pack. Does the cold pack emit or absorb energy? How do you know?

   g) Group Discussion Question: What very common endothermic reaction makes possible life on Earth as we know it?

5) Batteries
   Your instructor will show you how to make a battery.
   a) Hook your battery to a voltmeter. How much voltage does your battery produce? ______
   b) What causes a voltage difference between the anode and the cathode of the battery?
6) **Chemical and Physical Changes**
   a) What is the difference between a chemical reaction and a physical change?

11.4 **Rates of Chemical Reactions**

7) **Activation Energy**
   a) What is activation energy?

   b) Is activation energy required in endothermic reactions? ________

   c) Is activation energy required in exothermic reactions? ________

8) **Catalysts**
   a) What is the purpose of a catalyst?

   b) Your instructor will demonstrate the effect of a catalyst on hydrogen peroxide \( \text{H}_2\text{O}_2 \).
      1) What is the purpose of adding a piece of platinum to the beaker?
      2) Is the platinum used up in the reaction? ________
      3) Does the platinum change the outcome of the reaction? ________

11.5 **Chemistry of Fossil Fuel Combustion**

9) **Complete and Incomplete Combustion of Carbon**
   Fossil fuels give off energy when their carbon atoms combine with oxygen.

   a) Which carbon-oxygen compound is produced in **complete** combustion reactions of hydrocarbons, such as the combustion of wood, oil, or gasoline?
b) What is meant by an incomplete combustion reaction?

c) In incomplete combustion reactions, which carbon-oxygen compound is produced?

d) Are these reactions endothermic or exothermic? _________________

e) Group Discussion Question: Propane (C₃H₈) is a common gas used for home heating and outdoor cooking grills. Write a balanced equation for the complete combustion reaction when propane combines with oxygen to form carbon dioxide and water vapor.
1) Physical and chemical changes

Do the reactions described below represent a physical or chemical change?

a) Liquid water evaporates into water vapor _____________________________

b) A piece of iron expands when it is heated _____________________________

c) A piece of iron rusts when exposed to moist air ________________________

d) A hamburger cooking too long on a grill turns black ____________________

2) Combustion

Iron can combine with oxygen in two ways: rust slowly at room temperature or burn rapidly if heated in an atmosphere of pure oxygen.

Assume that the amounts of iron and oxygen that combine are the same in both reactions and that the same end product is produced.

How do the amounts of energy released in the two reactions compare? The energy released when iron rusts slowly is (less than, equal to, or greater than) the energy released when iron burns rapidly. _________________________

What is the reason for your answer?

3) Complete and incomplete combustion

Methane gas (CH₄) can react with oxygen in a complete combustion reaction to form carbon dioxide and water vapor:

\[ \text{C H}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O} \]

a) What reaction products result when methane and oxygen combine in an incomplete combustion reaction? ________________________________

b) Write a balanced chemical equation for this reaction.

c) Are these reactions exothermic or endothermic? ______________________