Student Worksheet: Methane Hydrate Model

Name: _____ Date: _____ Class: _____

Introduction

A **methane hydrate** is a type of **clathrate**, a chemical substance in which the molecules of one material (water, in this case) form an open lattice/cage that encloses molecules of another material (methane, in this case) without actually forming chemical bonds between the two materials. These solid, ice-like methane hydrates have a dodecahedral shape formed by the shared water molecules and are only visible via SEM (Scanning Electron Microscope).

Methane is produced in many environments by a group of Archaea known as methanogenic Archaea. These Archaea obtain energy by anaerobic metabolism through which they break down the organic material contained in once-living plants and animals. When this process takes place in deep ocean sediments, where there is high pressure and relatively low temperatures, methane hydrate develops. These conditions are common at specific depths within the seafloor sediment along continental margins but methane hydrates also form in permafrost areas.

Methane hydrates remain stable in deep-sea sediments for long periods of time; but if the surrounding temperature rises, they may become unstable. This occurs due to geologic or oceanographic processes that raise the temperature of deep-sea sediments to a point at which the methane hydrate ice cage melts and the free methane gas is released. This gas then percolates through the seafloor. These areas are called **methane seeps**. In some cases, these bubbles may get trapped by a shelf on the seafloor and form into patches of methane hydrate.

These methane seeps are often associated with incredibly unusual and possibly unique biological communities, living in this chemical-rich environment through chemosynthesis.

Additionally, the U.S. Geological Survey has estimated that on a global scale, methane hydrates may contain roughly twice the carbon contained in all reserves of coal, oil, and conventional natural gas combined. However, humans have not yet developed methods and technologies to efficiently and safely collect these gases for commercial use.

Learning Procedure

After watching the introductory videos and reading the information above, answer questions 1-3. Then, construct and study the methane hydrate model following the instructions provided by your teacher.

1. Define the following terms:

a. Clathrate: _____

_____

b. Hydrate: _____

_____

c. Methane Hydrate: _____

_____

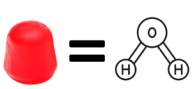
2. Label the methane hydrate model parts in these illustrations.

Color Key

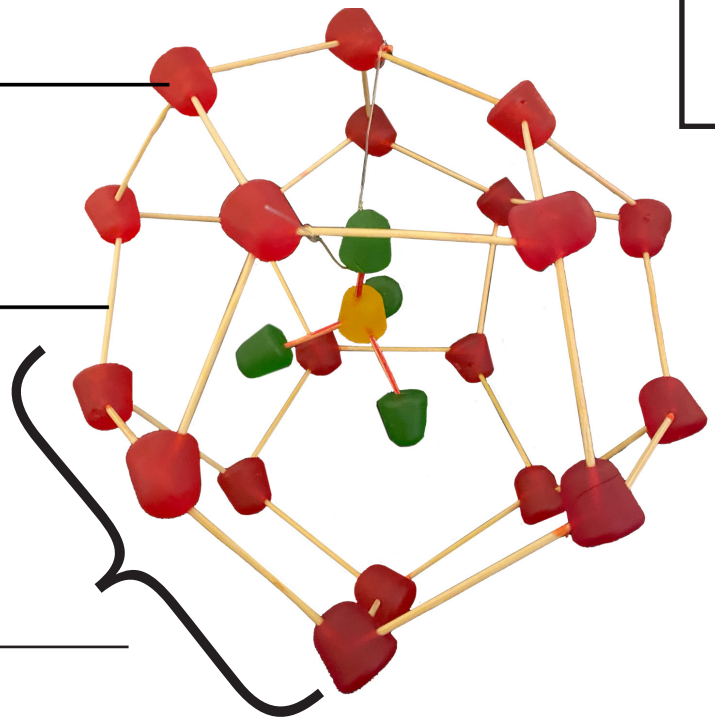
Water molecule (H_2O) = _____

Hydrogen (H) = _____

Carbon (C) = _____

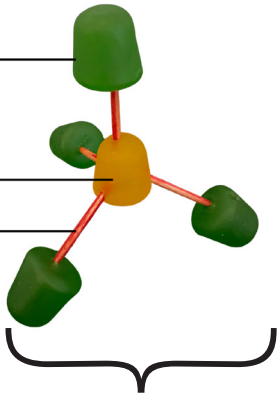


A. _____



B. _____

C. _____



D. _____

E. _____

F. _____

G. _____

3. Name that bond.

a. What bond(s) hold the atoms of a water molecule together? _____

b. What bond(s) hold all the water molecules together? _____

c. What bond(s) hold the atoms of the methane molecule together? _____

Putting the Pieces Together

Discussion Questions

4. Explain how methane hydrates are formed?

_____

_____

5. In what way is methane released from methane hydrates? How might you show that with your model?

_____

_____

6. Where are methane hydrates found?

_____

_____

7. Why are methane hydrates important?

_____

_____