Mission Messages and Binary

Name: _____ Date: _____

1. Read the four-flash language EASY

In the mission codebook, red means 0 and green means 1. Use the reference codebook on page 3.

1. Decode each transmission: `0001` = _____ `1000` = _____
2. Write the code for each report: Salt detected = _____ Return to shelter = _____
3. Circle every pair that differs in exactly one position:

`1010/1011` `0000/1111` `0100/0101`

4. A probe sends `1100`. One flash flips. Write all four possible received strings.

_____

_____

2. How many messages fit? EASY

Complete the doubling table.

Number of flashes n	1	2	3	4	5
Possible strings 2^n	2	_____	_____	_____	_____

Why are three flashes insufficient for sixteen reports?

_____

Why are four flashes exactly enough?

_____

3. Distance measures danger EASY

The Hamming distance is the number of positions where two strings differ.

a) $d(1010, 1011) =$ _____ $d(0000, 1110) =$ _____ $d(0110, 1001) =$ _____

b) Which pair above is most easily confused by one flipped bit? Explain.

_____

c) Mark the differing positions: `1 0 0 1` and `1 1 1 0`. Distance = _____

4. Nothing left over CHALLENGE

Every four-bit string already names a valid report. Explain why a single flipped flash can never be recognized as "not in the codebook."

_____

_____

Design a smaller codebook of four four-bit strings whose pairwise distances are as large as you can make them. Record the six pairwise distances. Codes: _____, _____, _____, _____

Distances: _____, _____, _____, _____, _____, _____

5. A transmission argument CHALLENGE

Mission Control receives `1011`, which means "Mission emergency." A radiation sensor says exactly one flash may have changed.

1. List every original four-bit string that could become `1011` after zero or one flips.

2. Use the codebook. What reports could those strings represent?

3. Can Mission Control determine the intended report? Why or why not?

4. What extra property should a safer codebook have?

6. Build and defend a code CHALLENGE

Choose three valid five-bit messages. Your goal is to keep every pair at distance at least 3.

Message	Five-bit code	Why it is far enough from the others
A		
B		
C		

For each message, write one string produced by flipping a single bit. Check that none of your examples could be interpreted as a one-bit error from two different messages.

Reflection EASY

Complete the sentence: "Extra information is useful because ..."

Original NILA Mission Codebook

Red = 0, green = 1. This reference contains all sixteen original reports.

Code	Mission report	Code	Mission report
0000	Systems normal	1000	Liquid water detected
0001	Battery low	1001	Organic molecules detected
0010	Camera ready	1010	Possible biological pattern
0011	Camera damaged	1011	Mission emergency
0100	Drill ready	1100	Radiation spike
0101	Drill jammed	1101	Surface crack opening
0110	Ice sample collected	1110	Warm plume detected
0111	Salt detected	1111	Return to shelter