

Detect, Repeat, or Repair?

Name: _____

Date: _____

1. The parity watchdog

EASY

Append one parity bit so the total number of 1s is even.

Four data bits	Parity bit	Five transmitted bits
1010		
1110		
0001		
1101		

- a) The receiver gets **10101**. Is its total parity even or odd? _____
 b) What can the watchdog conclude?

- c) Can it identify which position changed? Explain.

2. Detection is not correction

EASY

The protected word **11011** has even parity. One bit flips, but the receiver is only told that parity is now odd.

1. Write all five strings that could have been received after one flip.

2. Why does one parity bit detect a single error but fail to locate it?

3. Repeat the whole message

EASY

The original four-bit report is sent three times.

Copy 1 - original message	1	0	1	0
Copy 2	1	0	1	1
Copy 3	0	0	1	0
Column majority	___	___	___	___

Recovered message: _____. Use the codebook on page 3.

Decoded report: _____.

How many transmitted bits were used? _____ How many were extra copies? _____

4. When majority voting fails

CHALLENGE

Create three copies of one four-bit message so that two errors in the same column make majority voting return the wrong bit. Show the original and all three received copies. Original: _____ Copy

1: _____ Copy 2: _____ Copy 3: _____

State precisely what triple repetition guarantees and what it does not guarantee.

5. Compare the strategies**EASY**

Complete the table for a four-bit message.

Method	Total bits	Detect 1?	Correct 1?	Main limitation
No protection	4			
One parity bit	5			
Repeat three times	12			
Hamming(7,4)	7			

6. Communication budget**CHALLENGE**

A probe can transmit at most 70 bits during a short communication window.

- How many four-bit reports fit with no protection? _____
- How many fit if every report is repeated three times? _____
- How many fit using Hamming(7,4)? _____
- Which method would you choose if single-bit correction is required? Defend the tradeoff.

7. Burst-error thought experiment**CHALLENGE**

A radiation burst flips three adjacent transmitted bits. Compare two layouts:

- Layout A sends each three-copy message consecutively.
- Layout B interleaves bits from many different messages.

Which layout is more likely to spread the damage across different protected blocks? Why can spreading errors help?

Reflection**EASY**

Write D for detection and C for correction: “Something changed” = ____; “position 6 changed” = ____.

Original NILA Mission Codebook

All sixteen four-bit 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

Quick reminder: Four information bits have 16 possible patterns. A protection method deliberately sends extra information so the receiver can recognize or repair damage.