Data word
aka Memory word   — — — —
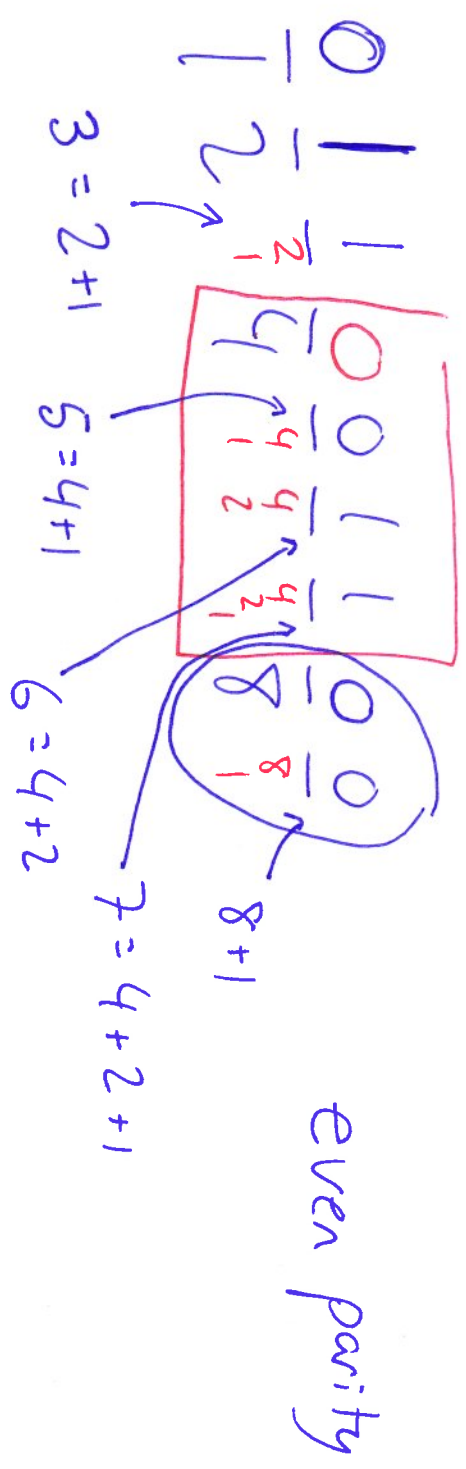
Add in (parity bits to create a codeword
        ⤷ aka redundant bits, check bits

e.g.   1 0 1 1 0   assume even parity

Codeword!

$$\overline{1} \ \overline{2} \ \underset{4}{1} \ \underset{8}{\textcolor{red}{0}} \ 1 \ 1 \ \underset{8}{\textcolor{red}{0}}$$

It takes a 9-bit codeword the 5 data bits
of the data word.

even parity

$$0 \mid 1 \mid 1 \mid 0 \mid 0 \mid 1 \mid 1 \mid 0 \mid 0$$
$$1 \mid 2 \mid 1 \mid 4 \mid 2 \mid 4 \mid 2 \mid 8 \mid 8$$
$$\quad\quad 1 \quad\quad 1 \quad 1 \quad 1 \quad 1 \quad 1$$

$$3 = 2+1$$
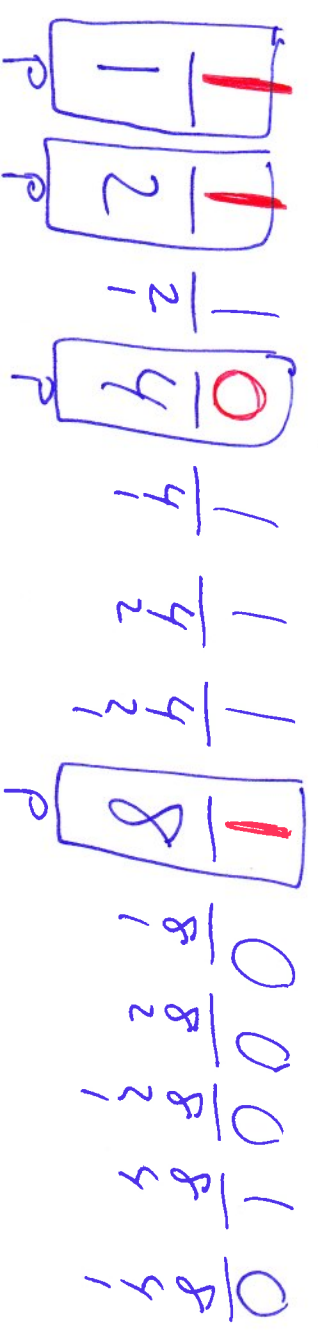$$5 = 4+1 \qquad 8+1$$
$$6 = 4+2 \qquad 7 = 4+2+1$$

express data-bit positions as sums of powers of 2.

We need to store 0110011100 in order to have error-detection/correction abilities for the data word

10110.

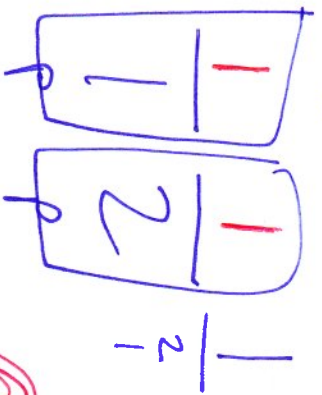_____

Create a Hamming codeword for the dataword

1111 00010

Try:
even
parity

1	2				
1	2				
P	P				

1	2	4		
1	2	4		
P	P	P		

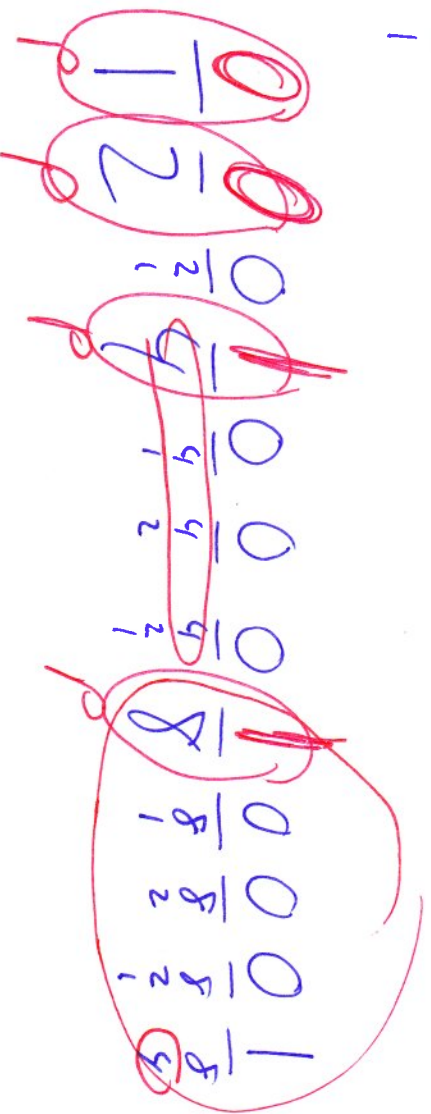| 1	2	4	8	0	0	0	1	0
1	2	4	4	8	8	8	8	0
	2	4	2	2	4	4		
			1	1	1		1	
P				P				

Create Hamming code words using even parity for the following memory words: (clearly label the parity bits)

(a) 1

$\dfrac{1}{1}$ $\dfrac{1}{2}$ $-\dfrac{1}{2}$
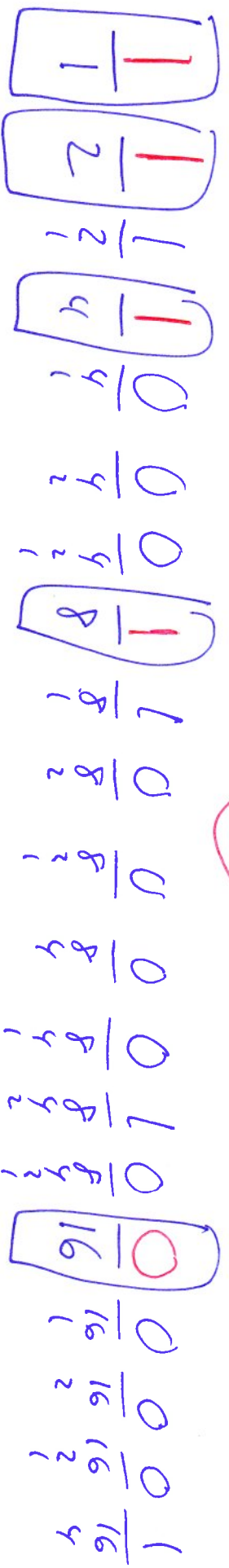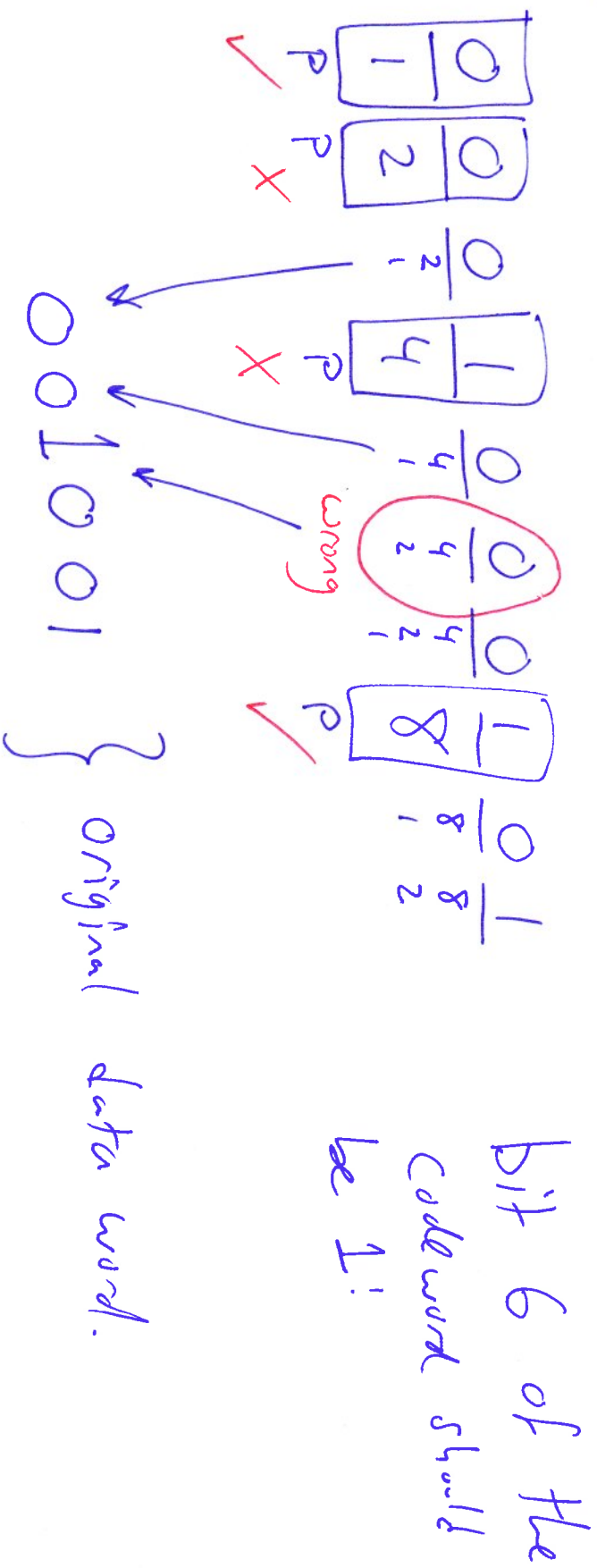
(b) 0000001

$\dfrac{1}{1}$ $\dfrac{1}{2}$ $-\dfrac{1}{2}$

$\dfrac{0}{1}$ $\dfrac{0}{2}$ $\dfrac{0}{-\frac{1}{2}}$ $\dfrac{1}{4}$ $\dfrac{0}{-\frac{1}{4}}$ $\dfrac{0}{\frac{2}{4}}$ $\dfrac{0}{-\frac{4}{4}}$ $\dfrac{1}{8}$ $\dfrac{0}{-\frac{1}{8}}$ $\dfrac{0}{-\frac{2}{8}}$ $\dfrac{0}{-\frac{4}{8}}$ $\dfrac{0}{-\frac{8}{8}}$

(c) 10 10 1111 0

$\dfrac{1}{1}$ $\dfrac{0}{2}$ $\dfrac{1}{4}$

$\dfrac{0}{1}$ $\dfrac{1}{2}$ $\dfrac{0}{4}$ $\dfrac{1}{8}$

$\dfrac{0}{1}$ $\dfrac{0}{\frac{1}{2}}$ $\dfrac{1}{\frac{4}{2}}$ $\dfrac{0}{\frac{1}{4}}$ $\dfrac{1}{\frac{2}{4}}$ $\dfrac{1}{\frac{4}{4}}$ $\dfrac{0}{\frac{1}{8}}$ $\dfrac{1}{\frac{2}{8}}$ $\dfrac{1}{\frac{4}{8}}$ $\dfrac{0}{\frac{8}{8}}$

(Code parity instead)

(d) 10 0100100100100001

$\dfrac{1}{1}$ $\dfrac{1}{2}$ $\dfrac{1}{4}$

$\dfrac{0}{\frac{1}{2}}$ $\dfrac{0}{\frac{4}{2}}$ $\dfrac{0}{\frac{1}{4}}$ $\dfrac{1}{8}$ $\dfrac{0}{-\frac{1}{8}}$ $\dfrac{0}{-\frac{2}{8}}$ $\dfrac{0}{-\frac{4}{8}}$ $\dfrac{0}{-\frac{8}{8}}$ $\dfrac{0}{16}$ $\dfrac{0}{\frac{1}{16}}$ $\dfrac{0}{\frac{2}{16}}$ $\dfrac{0}{\frac{4}{16}}$
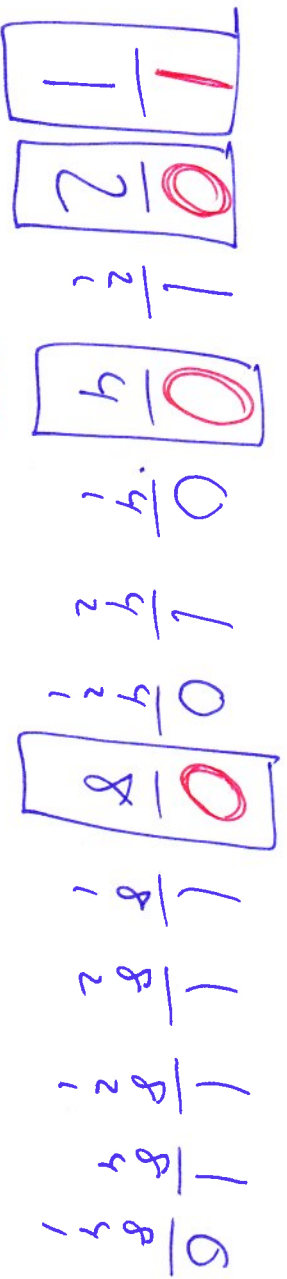
The following Hamming Codeword was created using even parity. Does it contain error(s)? Where? What was the original data word supposed to be?

0001 000101

0	0	0	1	0	0	0	1	0	1
P	P	1	P	2	4	4	P	1	1
1	2		4	1	2	2	8	8	8
								2	2

✓ ✗ ✗ (wrong) ✓

bit 6 of the
codeword should
be 1!

00**1**001 } original data word.

original data word.

Same question as previous page:

Codeword (even parity):

```
1  0  1  0  1  0
1     2     4
p  2     4     2
x  p  1  p  1
x  x     p
      x      2
```

wrong

1 1 0 1

Original data word