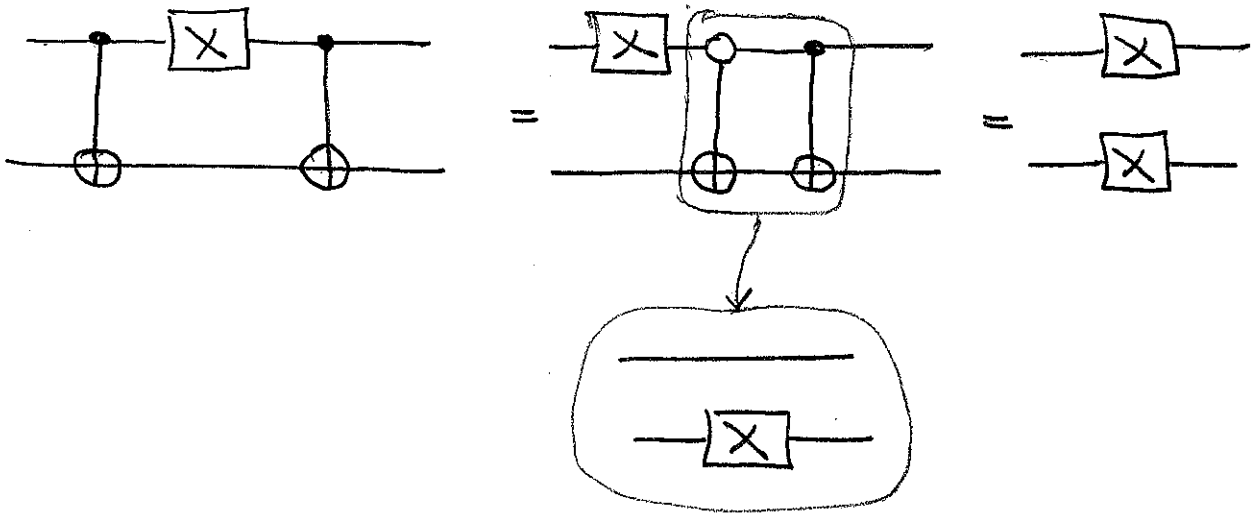
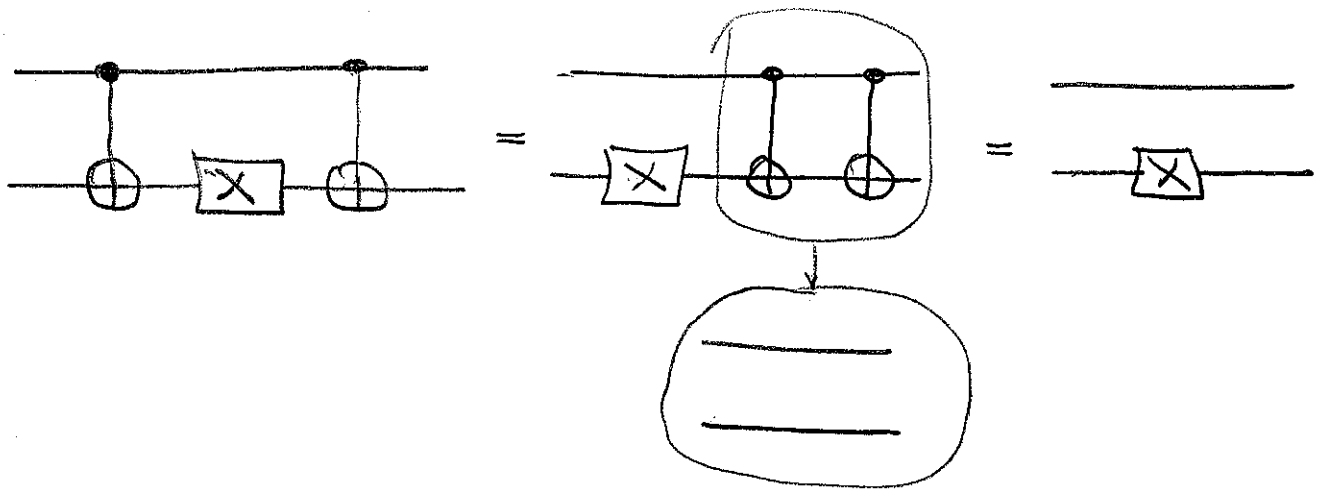
(a) C-C-NOT

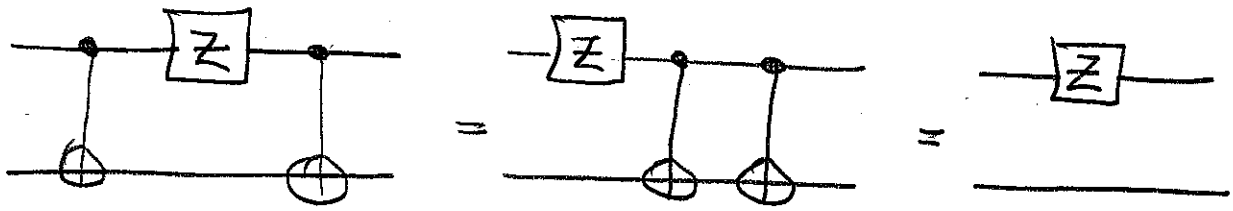
$$C(X\otimes I)C^{\dagger} = C(X\otimes I)C = X\otimes X$$



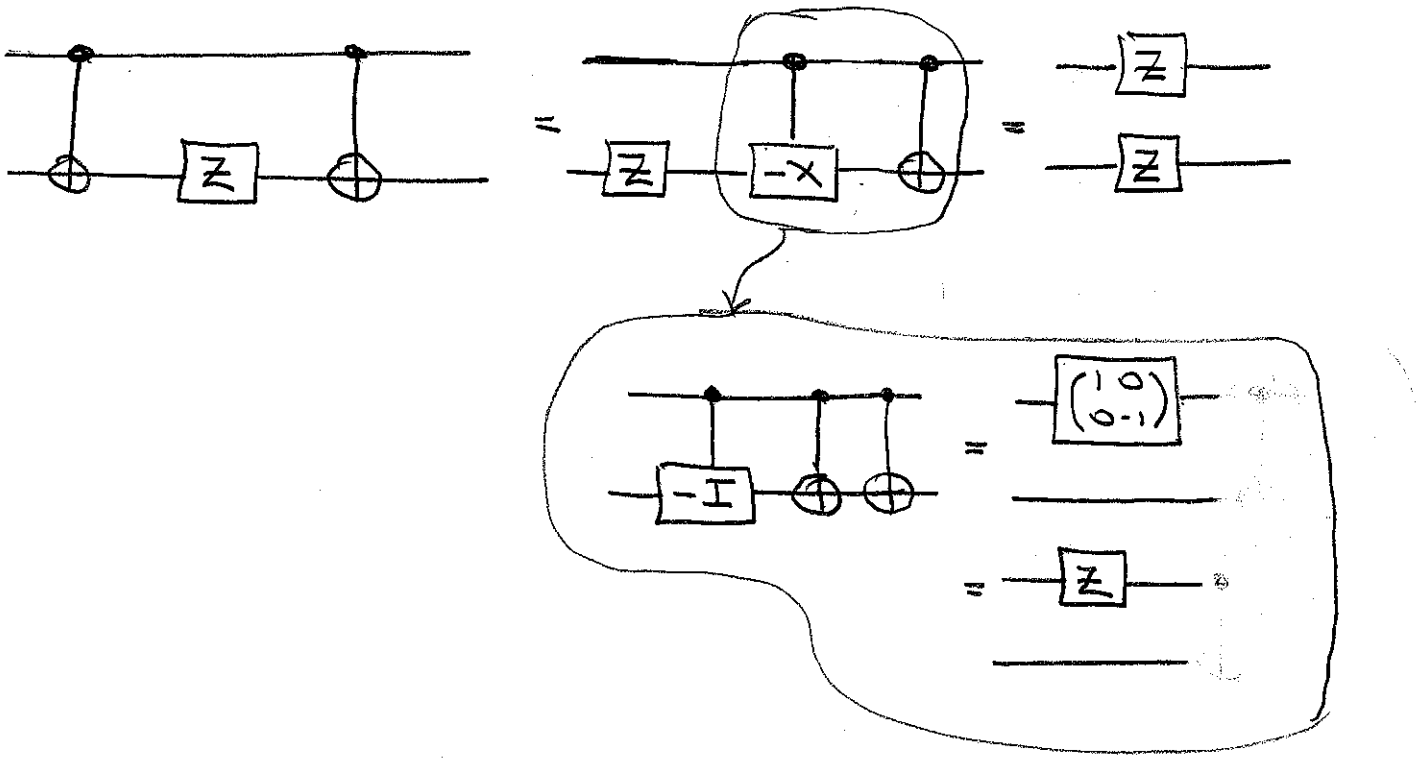
$$C(I\otimes X)C^{\dagger} = C(I\otimes X)C = I\otimes X$$



$$C(Z\otimes I)C^{\dagger} = C(Z\otimes I)C = Z\otimes I$$



$C(I \otimes Z) C^\dagger = C(I \otimes Z) C = Z \otimes Z$



$C(X \otimes I) C^\dagger = X \otimes X$

$C(I \otimes X) C^\dagger = I \otimes X$

$C(Z \otimes I) C^\dagger = Z \otimes I$

$C(I \otimes Z) C^\dagger = Z \otimes Z$

(b) The four Pauli products generate all the others, so we can get the rest by doing things like

$$C(X\otimes X)C^\dagger = C(X\otimes I)C^\dagger C(I\otimes X)C^\dagger$$
$$= (X\otimes X)(I\otimes X)$$
$$= X\otimes I$$

Of course, this one we can also get from

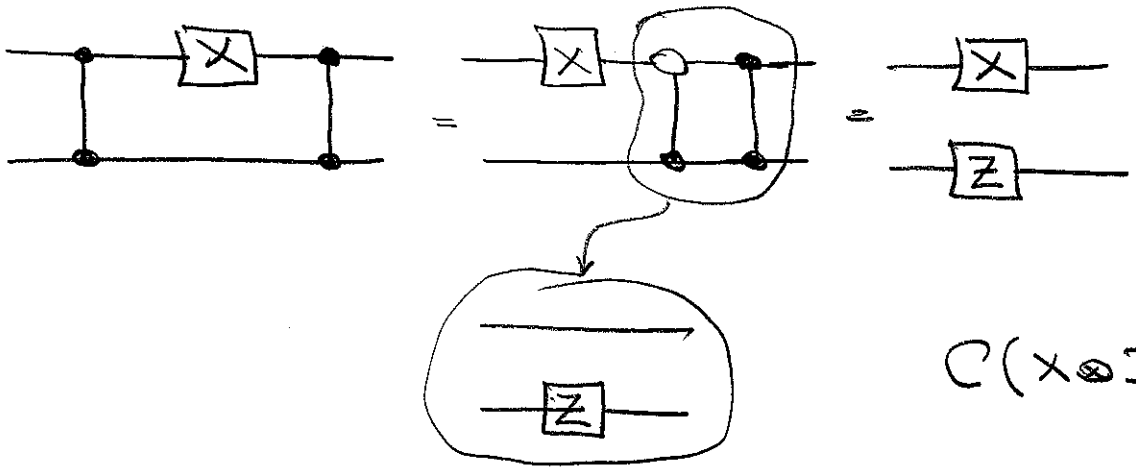
$$C(X\otimes I)C^\dagger = X\otimes X \Rightarrow C^\dagger(X\otimes X)C = X\otimes I$$
$$\parallel$$
$$C(X\otimes X)C^\dagger$$

since $C = C^\dagger$.

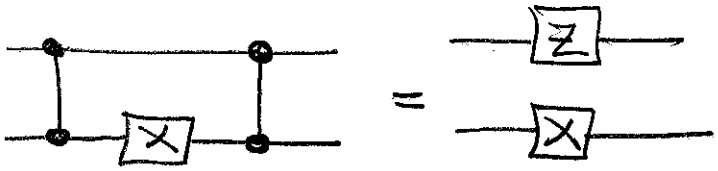
The full list is

$C(I\otimes I)C^\dagger = I\otimes I$	$C(X\otimes I)C^\dagger = X\otimes X$
$C(I\otimes X)C^\dagger = I\otimes X$	$C(X\otimes X)C^\dagger = X\otimes I$
$C(I\otimes Y)C^\dagger = Z\otimes Y$	$C(X\otimes Y)C^\dagger = Y\otimes Z$
$C(I\otimes Z)C^\dagger = Z\otimes Z$	$C(X\otimes Z)C^\dagger = -Y\otimes Y$
$C(Z\otimes I)C^\dagger = Z\otimes I$	$C(Y\otimes I)C^\dagger = Y\otimes X$
$C(Z\otimes X)C^\dagger = Z\otimes X$	$C(Y\otimes X)C^\dagger = Y\otimes I$
$C(Z\otimes Y)C^\dagger = I\otimes Y$	$C(Y\otimes Y)C^\dagger = -X\otimes Z$
$C(Z\otimes Z)C^\dagger = I\otimes Z$	$C(Y\otimes Z)C^\dagger = X\otimes Y$

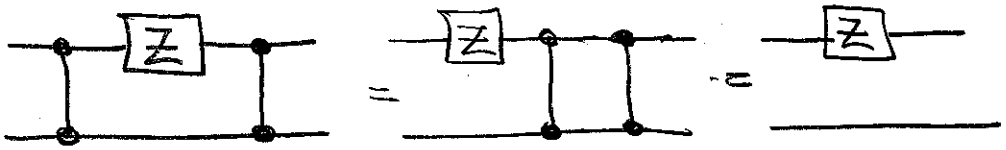
(c) C = C-SIGN



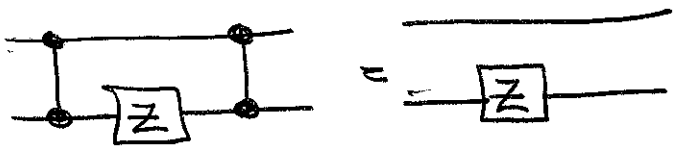
$C(X \otimes I)C^\dagger = X \otimes Z$



$C(I \otimes X)C^\dagger = Z \otimes X$



$C(Z \otimes I)C^\dagger = Z \otimes I$



$C(I \otimes Z)C^\dagger = I \otimes Z$

The full list is

$$C(I\otimes I)C^\dagger = I\otimes I$$
$$C(I\otimes X)C^\dagger = Z\otimes X$$
$$C(I\otimes Y)C^\dagger = Z\otimes Y$$
$$C(I\otimes Z)C^\dagger = I\otimes Z$$
$$C(Z\otimes I)C^\dagger = Z\otimes I$$
$$C(Z\otimes X)C^\dagger = I\otimes X$$
$$C(Z\otimes Y)C^\dagger = I\otimes Y$$
$$C(Z\otimes Z)C^\dagger = Z\otimes Z$$
$$C(X\otimes I)C^\dagger = X\otimes Z$$
$$C(X\otimes X)C^\dagger = Y\otimes Y$$
$$C(X\otimes Y)C^\dagger = -Y\otimes X$$
$$C(X\otimes Z)C^\dagger = X\otimes I$$
$$C(Y\otimes I)C^\dagger = Y\otimes Z$$
$$C(Y\otimes X)C^\dagger = -X\otimes Y$$
$$C(Y\otimes Y)C^\dagger = X\otimes X$$
$$C(Y\otimes Z)C^\dagger = Y\otimes I$$

(4) Superdense coding: