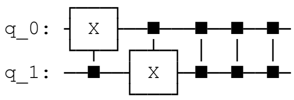
In [22]:

```
from qiskit import QuantumCircuit
from qiskit.circuit import Gate
from math import pi
import numpy as np
qc = QuantumCircuit(2)
#control
c = 1
#target
t = 0
```

In [44]:

```
# a controlled-Z
qc.cz(0,1)
qc.draw()
```

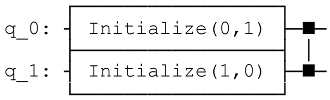
Out[44]:



In [74]:

```
qc = QuantumCircuit(2)
# also a controlled-Z
initial_state0 = [1,0]   # Define initial_state as |0>
initial_state1 = [0,1]   # Define initial_state as |1>
qc.initialize(initial_state1, 0) # Apply initialisation operation to the 0th qubit
qc.initialize(initial_state0, 1) # Apply initialisation operation to the 1th qubit
qc.cz(c,t)
qc.draw()
```

Out[74]:



In [75]:

```
svsim = Aer.get_backend('aer_simulator')
qc.save_statevector()
qobj = assemble(qc)
final_state = svsim.run(qobj).result().get_statevector()

# In Jupyter Notebooks we can display this nicely using Latex.
# If not using Jupyter Notebooks you may need to remove the
# array_to_latex function and use print(final_state) instead.
from qiskit.visualization import array_to_latex
array_to_latex(final_state, prefix="\\text{Statevector} = ")
```

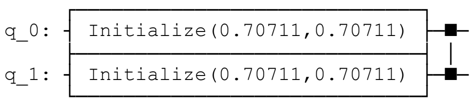
Out[75]:

$$\text{Statevector} = \begin{bmatrix} 0 & 1 & 0 & 0 \end{bmatrix}$$

In [81]:

```
qc = QuantumCircuit(2)
# also a controlled-Z
initial_state0 = [1/(np.sqrt(2)),1/(np.sqrt(2))]   # Define initial_state superposition of 1 and 0
qc.initialize(initial_state0, 0) # Apply initialisation operation to the 0th qubit
qc.initialize(initial_state0, 1) # Apply initialisation operation to the 1th qubit
qc.cz(c,t)
qc.draw()
```

Out[81]:



In [82]:

```
svsim = Aer.get_backend('aer_simulator')
qc.save_statevector()
qobj = assemble(qc)
final_state = svsim.run(qobj).result().get_statevector()

# In Jupyter Notebooks we can display this nicely using Latex.
# If not using Jupyter Notebooks you may need to remove the
# array_to_latex function and use print(final_state) instead.
from qiskit.visualization import array_to_latex
array_to_latex(final_state, prefix="\\text{Statevector} = ")
```

Out[82]:

$$\text{Statevector} = \begin{bmatrix} \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & -\frac{1}{2} \end{bmatrix}$$

In [ ]:

```
#The state vector shows the effect of the controlled Z gate on each qubit combination
# |00>,|01>,|10> and |11>
#each qubit has equal probability of being 0 or 1
```