Sample Questions exam

from https://slides.com/javafxpert/prep-qiskit-dev-cert-exam#/16

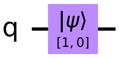
In [1]:

```
import math
import numpy as np

from qiskit import Aer, execute

from qiskit.circuit import ClassicalRegister, QuantumRegister, QuantumCircuit, library

from qiskit.quantum_info import Operator, average_gate_fidelity, process_fidelity,state_fidelity

from qiskit.visualization  import array_to_latex, plot_bloch_vector, plot_bloch_multivector, plot_histogram
```

In [2]:

```
qc = QuantumCircuit(1)
qc.initialize([1,0],0)
qc.draw()
```

Out[2]:



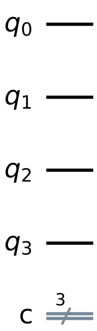
Question 1: Create QC

https://qiskit.org/documentation/stubs/qiskit.circuit.QuantumCircuit.html

In [3]:

```
qc = QuantumCircuit(4,3)
qc.draw()
```

Out[3]:



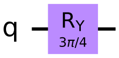
Question 2: mental gymnastics Bloch Sphere

see https://javafxpert.github.io/grok-bloch/

In [4]:

```
qc = QuantumCircuit(1)
qc.ry(3*math.pi/4,0)
qc.draw()
```

Out[4]:



Question 3: 3 ways to circuit

https://qiskit.org/documentation/stubs/qiskit.circuit.QuantumCircuit.html

https://qiskit.org/documentation/stubs/qiskit.circuit.QuantumRegister.html

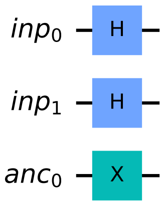
In [5]:

```
inp_reg = QuantumRegister(2, name='inp')
ancilla = QuantumRegister(1, name='anc')
qc = QuantumCircuit(inp_reg,ancilla)
```

In [6]:

```
# 1
qc.h(inp_reg)
qc.x(ancilla)
qc.draw()
```

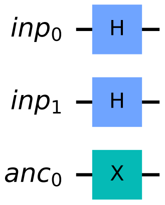
Out[6]:



In [7]:

```
#2
qc = QuantumCircuit(inp_reg,ancilla)

qc.h(inp_reg[0:2])
qc.x(ancilla[0])
qc.draw()
```

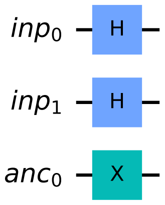
Out[7]:



In [8]:

```
#3
qc = QuantumCircuit(inp_reg,ancilla)

qc.h(inp_reg[0])
qc.h(inp_reg[1])
qc.x(ancilla[0])
qc.draw()
```

Out[8]:



In [ ]:

```

```

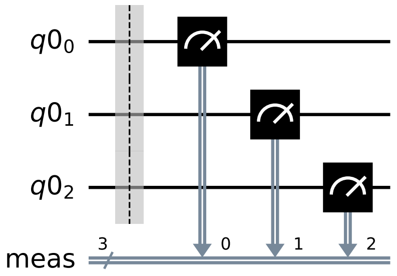
Question 4

https://qiskit.org/documentation/stubs/qiskit.circuit.QuantumCircuit.html

In [9]:

```
## measure_all

from qiskit.circuit import ClassicalRegister, QuantumRegister, QuantumCircuit

qreg = QuantumRegister(3)
qc = QuantumCircuit(qreg)

qc.measure_all()
qc.draw()
```

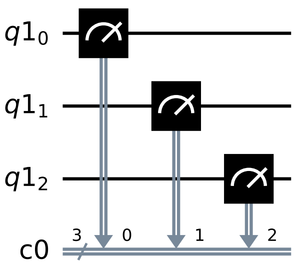
Out[9]:



In [10]:

```
from qiskit.circuit import ClassicalRegister, QuantumRegister, QuantumCircuit

qreg = QuantumRegister(3)
creg = ClassicalRegister(3)
qc = QuantumCircuit(qreg,creg)

qc.measure([0,1,2],[0,1,2])
qc.draw()
```

Out[10]:

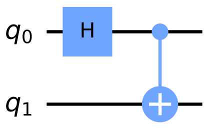


Question 5: Entanglement and 4 Bell states

https://qiskit.org/textbook/ch-gates/multiple-qubits-entangled-states.html

In [11]:

```
#1
bell = QuantumCircuit(2)
bell.h(0)
bell.cx(0,1)
display(bell.draw())

svsim = Aer.get_backend('aer_simulator')
bell.save_statevector()
final_state = svsim.run(bell).result().get_statevector()
array_to_latex(final_state, prefix="\\text{Statevector = }")
```

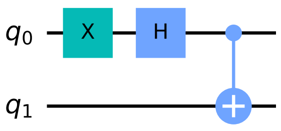


Out[11]:

$$\text{Statevector} = \begin{bmatrix} \frac{1}{\sqrt{2}} & 0 & 0 & \frac{1}{\sqrt{2}} \end{bmatrix}$$

In [12]:

```
#2
bell = QuantumCircuit(2)
bell.x(0)
bell.h(0)
bell.cx(0,1)
display(bell.draw())

svsim = Aer.get_backend('aer_simulator')
bell.save_statevector()
final_state = svsim.run(bell).result().get_statevector()
array_to_latex(final_state, prefix="\\text{Statevector = }")
```

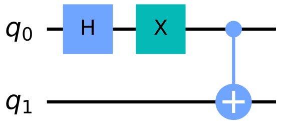


Out[12]:

$$\text{Statevector} = \begin{bmatrix} \frac{1}{\sqrt{2}} & 0 & 0 & -\frac{1}{\sqrt{2}} \end{bmatrix}$$

In [13]:

```
#3
bell = QuantumCircuit(2)
bell.h(0)
bell.x(0)
bell.cx(0,1)
display(bell.draw())

svsim = Aer.get_backend('aer_simulator')
bell.save_statevector()
final_state = svsim.run(bell).result().get_statevector()
array_to_latex(final_state, prefix="\\text{Statevector = }")
```

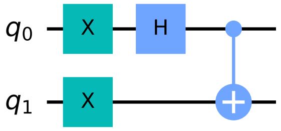


Out[13]:

$$\text{Statevector} = \begin{bmatrix} \frac{1}{\sqrt{2}} & 0 & 0 & \frac{1}{\sqrt{2}} \end{bmatrix}$$

In [14]:

```
#3
bell = QuantumCircuit(2)
bell.x(0)
bell.h(0)
bell.x(1)
bell.cx(0,1)
display(bell.draw())

svsim = Aer.get_backend('aer_simulator')
bell.save_statevector()
final_state = svsim.run(bell).result().get_statevector()
array_to_latex(final_state, prefix="\\text{Statevector = }")
```

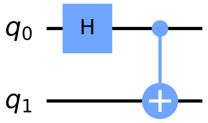


Out[14]:

$$\text{Statevector} = \begin{bmatrix} 0 & -\frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} & 0 \end{bmatrix}$$

In [15]:

```
#4
bell = QuantumCircuit(2)
bell.h(0)
bell.cx(0,1)
display(bell.draw())

svsim = Aer.get_backend('aer_simulator')
bell.save_statevector()
final_state = svsim.run(bell).result().get_statevector()
array_to_latex(final_state, prefix="\\text{Statevector = }")
```



Out[15]:

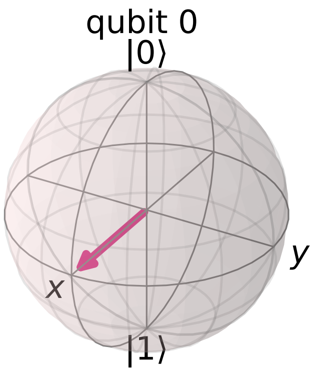
$$\text{Statevector} = \begin{bmatrix} \frac{1}{\sqrt{2}} & 0 & 0 & \frac{1}{\sqrt{2}} \end{bmatrix}$$

Question 6: Gym on Bloch sphere, `plot_bloch_multivector` vs `plot_bloch_vector`

In [16]:

```
qc = QuantumCircuit(1,1)
## Wanna go to |+>
### code
qc.h(0)
###
simulator = Aer.get_backend('statevector_simulator')
job = execute(qc, simulator)
result = job.result()
outputstate = result.get_statevector(qc)
plot_bloch_multivector(outputstate)
```

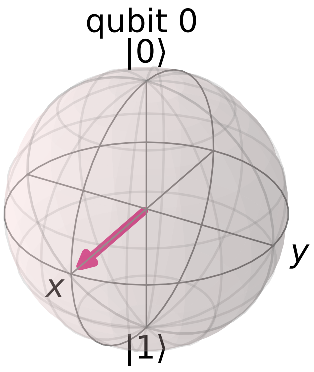
Out[16]:



In [17]:

```
qc = QuantumCircuit(1,1)
## Wanna go to |+>
### code
qc.ry(math.pi/2,0)
###
simulator = Aer.get_backend('statevector_simulator')
job = execute(qc, simulator)
result = job.result()
outputstate = result.get_statevector(qc)
plot_bloch_multivector(outputstate)
```

Out[17]:



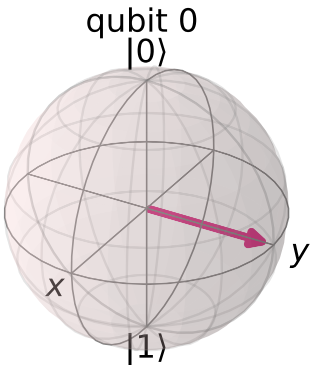
Question7: Gate operations

https://quantum-computing.ibm.com/composer/docs/iqx/operations_glossary

In [18]:

```
qc = QuantumCircuit(1)
qc.h(0)
qc.s(0) ## Pi/2 rotation

svsim = Aer.get_backend('statevector_simulator')
statevector = svsim.run(qc).result().get_statevector()
plot_bloch_multivector(statevector)
```

Out[18]:



Question 8: Bell state and initialize

https://qiskit.org/documentation/stubs/qiskit.circuit.QuantumCircuit.html

2 fragments of code

In [19]:

```
qc = QuantumCircuit(2)
```

```
### code here -> Want [1/sqt(2), 0 , 0 , 1/sqrt(2)]
qc.h(0)
qc.cx(0,1)
###


svsim = Aer.get_backend('statevector_simulator')
statevector = svsim.run(qc).result().get_statevector()
array_to_latex(statevector)
```

Out[19]:

$$\begin{bmatrix} \frac{1}{\sqrt{2}} & 0 & 0 & \frac{1}{\sqrt{2}} \end{bmatrix}$$

In [20]:

```
qc = QuantumCircuit(2)

### code here -> Want [1/sqt(2), 0 , 0 , 1/sqrt(2)]
v = [1/math.sqrt(2), 0, 0, 1/math.sqrt(2)]
qc.initialize(v,[0,1])
###


svsim = Aer.get_backend('statevector_simulator')
statevector = svsim.run(qc).result().get_statevector()
array_to_latex(statevector)
```

Out[20]:

$$\begin{bmatrix} \frac{1}{\sqrt{2}} & 0 & 0 & \frac{1}{\sqrt{2}} \end{bmatrix}$$

Question 9: Qiskit API, multi-qubit gates

https://qiskit.org/documentation/apidoc/circuit_library.html

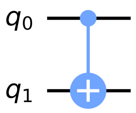
See `CXGate` , `MCXGate`

3 correct

In [21]:

```
## produce a multi-qubit other than CNOT
qc = QuantumCircuit(2)
qc.cx(0,1)
qc.draw()
```

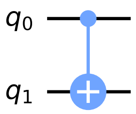
Out[21]:



In [22]:

```
## produce a multi-qubit other than CNOT
qc = QuantumCircuit(2)
qc.cnot(0,1)
qc.draw()
```

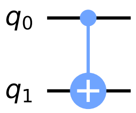
Out[22]:



In [23]:

```
## produce a multi-qubit other than CNOT
qc = QuantumCircuit(2)
qc.mct([0],1) #### Notice list for first qubit: can have more than 1 control qubit
qc.draw()
```

Out[23]:



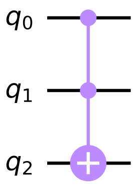
Question 10: Qiskit API, Toffoli gate

3 codes

In [24]:

```
#1

qc = QuantumCircuit(3)
qc.ccx(0,1,2)
qc.draw()
```

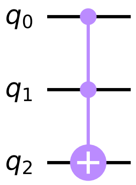
Out[24]:



In [25]:

```
#2
qc = QuantumCircuit(3)
qc.mct([0,1],2)
qc.draw()
```

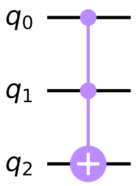
Out[25]:



In [26]:

```
#3
from qiskit.circuit.library import CXGate

qc = QuantumCircuit(3)
ccx = CXGate().control() ## Can create ccx with multiple controls
qc.append(ccx,[0,1,2])
qc.draw()
```

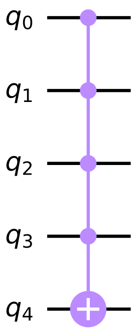
Out[26]:



In [27]:

```
#test
from qiskit.circuit.library import CXGate

qc = QuantumCircuit(5)
c4cx = CXGate().control(3) ## Can create ccx with multiple controls: 3 extra controls
qc.append(c4cx,[0,1,2,3,4])
qc.draw()
```

Out[27]:



Question 11: Qiskit API, barrier

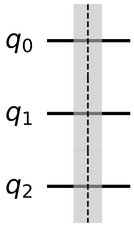
2 codes

- list
- empty

In [28]:

```
## Place a barrier across all qubits
qc = QuantumCircuit(3)

### code
qc.barrier([0,1,2])
###

qc.draw()
```

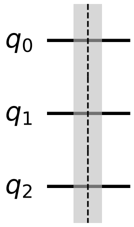
Out[28]:



In [29]:

```
## Place a barrier across all qubits
qc = QuantumCircuit(3)

### code
qc.barrier()
###

qc.draw()
```

Out[29]:



In [ ]:

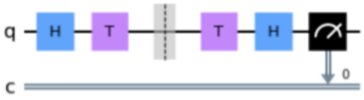
```

```

Question 12: Barrier, optimizing circuits

https://www.youtube.com/watch?v=tS2CMOyWFMQ

barrier: instructions to the transpiler

What fragment codes are equivalent to circuit if we remove the barrier

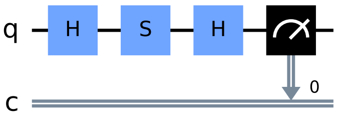


$TT = S$

In [30]:

```
qc = QuantumCircuit(1,1)
qc.h(0)
qc.s(0)
qc.h(0)
qc.measure(0,0)
qc.draw()
```

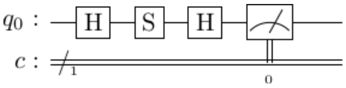
Out[30]:



In [31]:

```
qc.draw(output='latex')
```

Out[31]:



In [ ]:

Question 13: Barrier, circuit depth

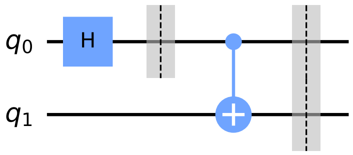
Depth does not include `barrier` or `snapshot`

In [52]:

```
qc = QuantumCircuit(2)

qc.h(0)
qc.barrier(0)
qc.cx(0,1)
qc.barrier([0,1])

print(qc.depth())

qc.draw()
```

```
2
```

Out[52]:

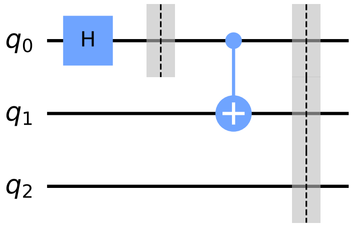


In [55]:

```
qc = QuantumCircuit(3)

qc.h(0)
qc.barrier(0)
qc.cx(0,1)
qc.barrier([0,1,2])

print(qc.depth())

qc.draw()
```

```
2
```

Out[55]:



Question 14: `execute` function parameters, coupling map, Aer `qasm_simulator`

code snippet for

- 1024 times
- QASM simulator
- coupling map that connects 3 qubits linearly

In [33]:

```
qc = QuantumCircuit(3)
#display(qc.draw())
## code
qasm_sim = Aer.get_backend("qasm_simulator")
couple_map = [[0,1],[1,2]]
job = execute(qc, backend=qasm_sim, coupling_map=couple_map, shots=1024)
##
# result = job.result()
# counts = result.get_counts()
# print(counts)
```

In [ ]:

Question 15: `execute` function parameters, coupling map, BasicAer `qasm_simulator`

https://qiskit.org/documentation/apidoc/providers_basicaer.html

https://qiskit.org/documentation/apidoc/execute.html qubits coupled in a custom way

In [34]:
```
from qiskit import QuantumCircuit, execute, BasicAer
backend = BasicAer.get_backend('qasm_simulator')
qc = QuantumCircuit(3)
#qc.append()

execute(qc, backend=backend, shots=1024, coupling_map=[[0,1],[1,2]])
```

```
No classical registers in circuit "circuit-157", counts will be empty.
```

Out[34]:
```
<qiskit.providers.basicaer.basicaerjob.BasicAerJob at 0x7f93f83197c0>
```

Question 16: BasicAer Simulators

https://qiskit.org/documentation/apidoc/providers_basicaer.html

In [35]:
```
backend = BasicAer.get_backend("qasm_simulator")
backend = BasicAer.get_backend("statevector_simulator")
backend = BasicAer.get_backend("unitary_simulator")
```

In [ ]:
```

```

Question 17: Assigning BasicAer simulators

https://qiskit.org/documentation/tutorials/circuits/2_plotting_data_in_qiskit.html

Assign statevector simulator to backend

In [36]:
```
backend = BasicAer.get_backend("statevector_simulator")
```

In [ ]:
```

```

Question 18: QIS, creating an Operator

https://qiskit.org/documentation/stubs/qiskit.quantum_info.Operator.html

Yield an operator that represent a single-qubit X gate

In [37]:
```
qc = QuantumCircuit(1)
qc.x(0)
op = Operator(qc)

print(op.data)
```

```
[[0.+0.j 1.+0.j]
 [1.+0.j 0.+0.j]]
```

In [ ]:
```

```

Question 19: `quantum_info` API, process, and gate fidelity

What fidelity result for these two operators, which differ only by a global phase?

In [38]:
```
op_a = Operator(library.XGate())
op_b = np.exp(1j*0.5)*Operator(library.XGate())

print(average_gate_fidelity(op_a, op_b))
print(process_fidelity(op_a, op_b))
```

```
1.0
1.0
```

In [ ]:
```

```

Question 20: Mentally calculate statevector from circuit

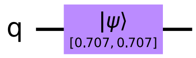
Remeber order is from right to left!!</color>

In [39]:
```
qc = QuantumCircuit(2,2)
qc.x(0)
qc.measure([0,1],[0,1])

simulator = Aer.get_backend('qasm_simulator')
result = execute(qc, backend=simulator, shots=1000).result()
counts = result.get_counts()
print(counts)
```

```
{'01': 1000}
```

Udemy

In [40]:
```
a = 1/np.sqrt(2)
desired_state = [a,np.sqrt(1-a**2)]
qc = QuantumCircuit(1)
qc.initialize(desired_state,0)

display(qc.draw())

back_sv = BasicAer.get_backend('statevector_simulator')
result = execute(qc, back_sv).result()
qc_sv = result.get_statevector(qc)
state_fidelity(desired_state, qc_sv)
```



Out[40]:
```
0.9999999999999998
```

In [41]:
```
q = QuantumRegister(1,'q')
qc = QuantumCircuit(q)
qc.y(0)
backend_unitary = BasicAer.get_backend('unitary_simulator')
result = execute(qc,backend_unitary).result().get_unitary(decimals=3)
#print(result.get_counts())
```

In [43]:
```
from qiskit import *
import qiskit.tools.jupyter

from qiskit import IBMQ
# APIKEY ='1b4757e26ee36220c5ca60046f2c68b1e5c3af2dd2869a139453a03ea22dee2526af80384526e94557b625c992f7cb96c6413e99bea15da8b416c950fe11cc30'
# IBMQ.save_account('MY_API_TOKEN')
IBMQ.load_account()


%qiskit_backend_overview
```

In [44]:
```
%qiskit_version_table
```

```
/Users/ufranca/opt/anaconda3/lib/python3.8/site-packages/qiskit/aqua/__init__.py:86: DeprecationWarning: The package qiskit.aqua is deprecate
d. It was moved/refactored to qiskit-terra For more information see <https://github.com/Qiskit/qiskit-aqua/blob/main/README.md#migration-guide
>
  warn_package('aqua', 'qiskit-terra')
```

Version Information

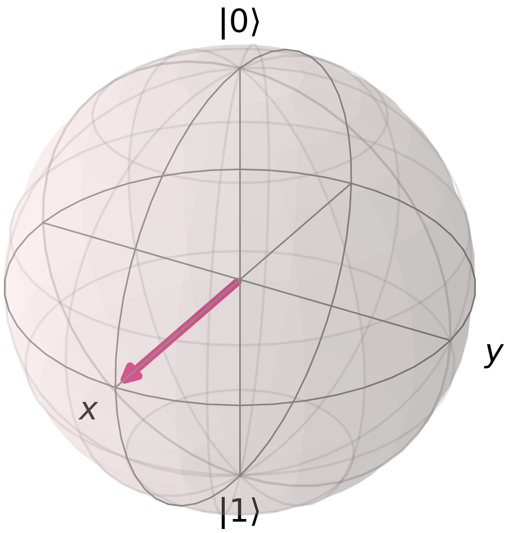
Qiskit Software	Version
qiskit-terra	0.18.3
qiskit-aer	0.9.0
qiskit-ignis	0.6.0
qiskit-ibmq-provider	0.16.0
qiskit-aqua	0.9.5
qiskit	0.30.1
qiskit-nature	0.2.2
qiskit-finance	0.2.1
qiskit-optimization	0.2.3
qiskit-machine-learning	0.2.1
System information	
Python	3.8.8 (default, Apr 13 2021, 12:59:45) [Clang 10.0.0]
OS	Darwin
CPUs	8
Memory (Gb)	16.0
	Sat Jan 29 16:42:47 2022 EST

In [45]:
```
qiskit.execute_function
```

Out[45]:
```
<module 'qiskit.execute_function' from '/Users/ufranca/opt/anaconda3/lib/python3.8/site-packages/qiskit/execute_function.py'>
```

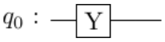
In [46]:
```
plot_bloch_vector([1,0,0])
```

Out[46]:



```
In [47]: qc.draw(output='latex')
```

Out[47]:



IBM test

```
In [70]: from qiskit import IBMQ
         import qiskit.tools.jupyter
         %matplotlib inline

         from qiskit import IBMQ
         # APIKEY ='1b4757e26ee36220c5ca60046f2c68b1e5c3af2dd2869a139453a03ea22dee2526af80384526e94557b625c992f7cb96c6413e99bea15da8b416c950fe11cc30'
         # IBMQ.save_account('MY_API_TOKEN')
         IBMQ.load_account()

         # IBMQ.save_account(APIKEY, overwrite=True)

         %qiskit_backend_overview
```

```
ibmqfactory.load_account:WARNING:2022-01-29 19:34:57,222: Credentials are already in use. The existing account in the session will be replace
d.
```

```
In [72]: backend.status()
```

```
Out[72]: <qiskit.providers.models.backendstatus.BackendStatus object at 0x7f9418e12d00>
```

name: statevector_simulator

version: 1, **pending jobs**: 0

status:

```
In [73]: BasicAer.backends()
```

```
Out[73]: [<QasmSimulatorPy('qasm_simulator')>,
          <StatevectorSimulatorPy('statevector_simulator')>,
          <UnitarySimulatorPy('unitary_simulator')>]
```

```
In [57]: # from qiskit import IBMQ

         # IBMQ.load_account()

         # provider = IBMQ.get_provider(group='open', project='main')
         # system = provider.get_backend('ibmq_manila')
         # system.configuration()
```

```
ibmqfactory.load_account:WARNING:2022-01-29 16:50:25,861: Credentials are already in use. The existing account in the session will be replace
d.
Out[57]: <qiskit.providers.models.backendconfiguration.PulseBackendConfiguration at 0x7f93d821f550>
```

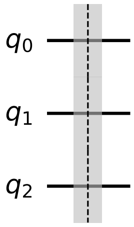
```
In [58]: # import qiskit.providers.ibmq.jupyter
         # IBMQ.load_account()

         # provider = IBMQ.get_provider(group='open', project='main')
         # system = provider.get_backend('ibmq_manila')
         # backend
```

```
ibmqfactory.load_account:WARNING:2022-01-29 16:50:29,669: Credentials are already in use. The existing account in the session will be replace
d.
Out[58]: <StatevectorSimulatorPy('statevector_simulator')>
```

In [66]:

```
qc = QuantumCircuit(3)
qc.barrier(0,1,2)
qc.draw()
```

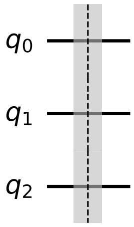
Out[66]:



In [68]:

```
qc = QuantumCircuit(3)
qc.barrier([0,1,2])
qc.draw()
```

Out[68]:



In [ ]:

In [ ]: