Qiskit v2.x Certification — Practice Exam

Instructions:

- Choose the best answer for each multiple-choice question.
- Some questions require knowledge of Qiskit primitives (Sampler, Estimator), OpenQASM 3, circuit building, measurement, and quantum state probabilities.
- Try to solve without external help; check explanations afterwards.

1. In Qiskit v2.x, what is the primary function of the **Sampler** primitive?
   A. Compute expectation values of observables
   B. Return a probability distribution over measurement outcomes
   C. Optimize circuits before execution
   D. Compile to OpenQASM 3

2. Which primitive is most appropriate to compute expectation values of Pauli operators given parameterized circuits?
   A. Sampler
   B. Estimator
   C. Session
   D. CircuitSampler

3. Suppose you have a single qubit in state $|0\rangle$. You apply $R_Y\left(\frac{\pi}{2}\right)$. What is the probability of measuring $|0\rangle$?
   A. 1.0
   B. 0.5
   C. $\frac{\sqrt{2}}{2}$
   D. 0

4. You apply an H gate to $|0\rangle$. What is the resulting state (up to global phase)?
   A. $|0\rangle$
   B. $|1\rangle$
   C. $\frac{1}{\sqrt{2}}\big(|0\rangle + |1\rangle\big)$
   D. $\frac{1}{\sqrt{2}}\big(|0\rangle - |1\rangle\big)$

5. You apply an H gate to $|1\rangle$. What is the resulting state (up to global phase)?

A. $|0\rangle$

B. $|1\rangle$

C. $\frac{1}{\sqrt{2}}\big(|0\rangle + |1\rangle\big)$

D. $\frac{1}{\sqrt{2}}\big(|0\rangle - |1\rangle\big)$

6. In Qiskit, which instruction prevents the compiler from reordering gates (i.e. serves as a barrier)?

   A. `barrier()`

   B. `delay()`

   C. `snapshot()`

   D. `noop()`

7. To merge two circuits `qc1` and `qc2` sequentially so that operations in `qc2` execute after `qc1`, which method is correct?

   A. `qc1.compose(qc2)`

   B. `qc1.combine(qc2)`

   C. `qc1 + qc2`

   D. `qc1.merge(qc2)`

8. What is the effect of applying an X-gate to $|1\rangle$?

   A. Produces $|0\rangle$

   B. Produces $|1\rangle$

   C. Creates a superposition

   D. Adds a phase

9. In OpenQASM 3, which of these is a valid *classical* data type?

   A. `qubit`

   B. `operator`

   C. `int`

   D. `quantum`

10. Which Qiskit method would you use to export a circuit into a QASM 3 file?

    A. `qc.to_qasm()`

    B. `qiskit.qasm3.dump(qc, file)`

    C. `qc.export()`

    D. `qasm3.save(qc, file)`

11. Which of the following is a valid Qiskit command to define a circuit with 3 qubits and 3 classical bits?

    A. `QuantumCircuit(3, 3)`

    B. `QuantumCircuit(3)`

    C. `QuantumCircuit(QuantumRegister(3), ClassicalRegister(3))`

    D. Both A and C

12. What is the probability of measuring $|1\rangle$ after applying $R_X\left(\frac{\pi}{4}\right)$ to $|0\rangle$?

    A. 0.1464

    B. 0.5

    C. 0.8536

    D. 1.0

13. Which of the following execution modes is **not** a Qiskit Runtime job mode?

    A. `batch`

    B. `session`

    C. `classical`

    D. `parallel`

14. What does the `ParameterVector` class in Qiskit help you do?

    A. Simulate circuits more efficiently

    B. Create many parameterized gates in a vectorized fashion

    C. Perform measurements

    D. Optimize circuits

15. If you have a qubit in an equal superposition $\frac{1}{\sqrt{2}}\big(|0\rangle + |1\rangle\big)$ and you `reset()` it, what is its state before measurement?

    A. $|0\rangle$

    B. $|1\rangle$

    C. $\frac{1}{\sqrt{2}}\big(|0\rangle + |1\rangle\big)$

    D. Indeterminate

16. Which Qiskit object is used to keep a backend warm (i.e. reuse the same compilation/connection) over multiple jobs?

    A. Session

    B. Sampler

    C. Estimator

D. Circuit

17. In Qiskit v2.x, how do you set the number of shots (repetitions) for a Sampler?
    A. `sampler.options.shots = ...`
    B. `sampler.options.repetitions = ...`
    C. `sampler.options.default_shots = ...`
    D. `sampler.set_shots(...)`

18. When running multiple circuits via a Sampler, which method is used?
    A. `sampler.run([qc1, qc2, ...])`
    B. `Session.run([qc1, qc2, ...])`
    C. `execute([qc1, qc2, ...])`
    D. `Estimator.run([qc1, qc2, ...])`

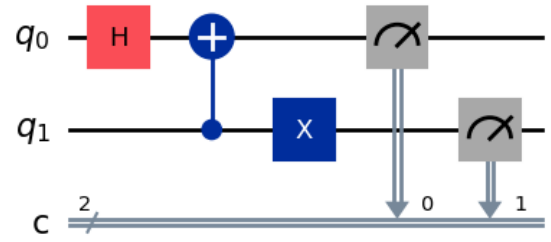
19. In a 2-qubit circuit, which gate entangles qubits 0 and 1?
    A. $H(0)$
    B. $X(1)$
    C. $CX(0, 1)$
    D. $RZ(\pi)$

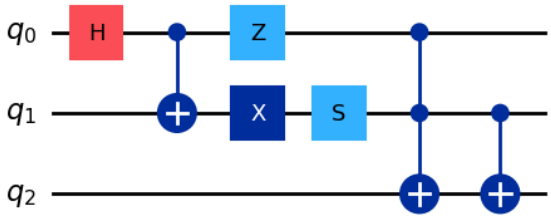
20. Which of these is an error-mitigation technique (not full error correction)?
    A. Zero Noise Extrapolation
    B. Surface code
    C. Steane code
    D. Shor code

21. What is the minimum number of qubits needed to represent 16 basis states?
    A. 3
    B. 4
    C. 8
    D. 16

22.) What is the output after executing the following circuit?
    A. 11 and 00
    B. 01 and 10
    C. 11 and 01
    D. 10 and 11

23. What is the depth of the given circuit?





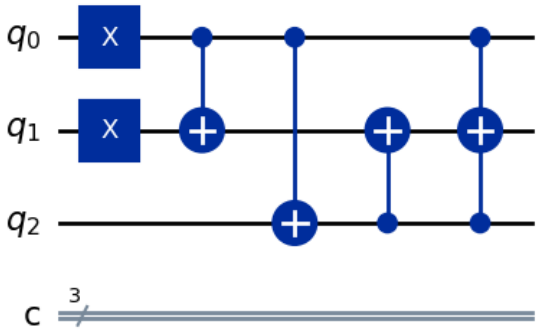
A. 4

B. 5

C. 6

D. 7

24. Assuming the fragment below, which code fragments would produce the circuit illustrated?



A.
```
qc = QuantumCircuit(3,3)
for i in range(2):
  qc.x(i)
for j in range(3):
  qc.cx(j, j-1)
qc.ccx(0,2,1)
qc.draw(output='mpl')
```

B.
```
qc = QuantumCircuit(3,3)
qc.x([0,1])
qc.cx(0,1)
qc.cx(0,2)
qc.cx(2,1)
qc.ccx(0,2,1)
qc.draw(output='mpl')
```

C.
```
 qc = QuantumCircuit(3,3)
for i in range(3):
  qc.x(i)
for j in range(3):
   qc.cx(j-1,j)
qc.ccx(0,1,2)
qc.draw(output='mpl')
```

D.
```
 qc = QuantumCircuit(3,3)
qc.x([0,1])
qc.cx(1,0)
qc.cx(0,2)
qc.cx(2,1)
qc.ccx(0,1,2)
qc.draw(output='mpl')
```

25. Which of the following gates can be used to build any single qubit gate?

    A. U gate

    B. Z gate

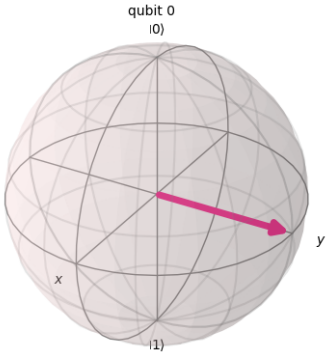
    C. P gate

    D. I gate

    E. All of the above

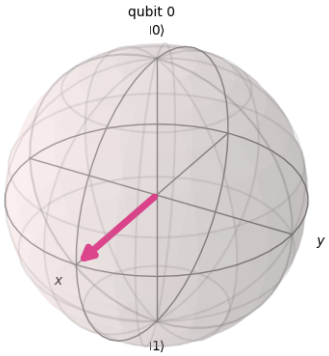
26. Select the correct output bloch sphere when the given code is executed

```
qc = QuantumCircuit(1)
qc.h(0)
qc.x(0)
qc5.ry(pi/2, 0)
qc5.rx(-pi/2, 0)
qc5.x(0)
```

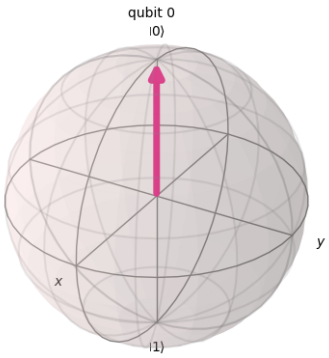


A. .

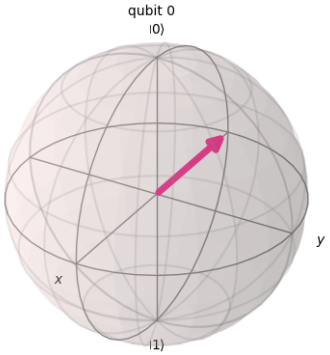
B. .



C. .



D. .



27. S-gate is a Qiskit phase gate with what value of the phase parameter?

    A. $\pi/4$

    B. $\pi/2$

    C. $\pi/8$

    D. π

28. Which one of the following code fragments will generate the given output?

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & -1 \end{bmatrix}$$

    A.
    ```
    p = Pauli('IZ')
    print(p.to_matrix())
    ```

    B.
    ```
    p = Pauli('-II')
    print(p.to_matrix())
    ```

    C.
    ```
    p = Pauli('-ZI')
    print(p.to_matrix())
    ```

    D.
    ```
    p = Pauli('ZZ')
    print(p.to_matrix())
    ```

Answer Key:

1. B
2. B
3. B
4. D
5. C
6. A
7. A
8. A
9. C
10. B
11. D
12. A
13. C
14. B
15. A
16. A
17. A
18. A
19. C
20. A
21. B
22. C
23. C
24. A
25. C.D
26. B
27. D
28. A