SOME SAMPLE MATERIALS from https://www.physport.org/curricula/ACEQIS/

Below, just a few samples to get a flavor for the sorts of materials you will find.
We ask that you make an effort to personalize any of these material you use to match your own goals and population, as well as to avoid having materials (and solutions!) too easily available online. Many of these materials have been tested in our courses at CU Boulder and Cal State Fullerton.

For more explanation on how to use active learning techniques in advanced courses, see our AJP article: "Adaptable research-based materials for teaching quantum mechanics", S. Pollock, G. Passante, H. Sadaghiani, *Am. J. Phys.* 91, 40–47 (2023)
https://doi.org/10.1119/5.0109124

Clicker questions:

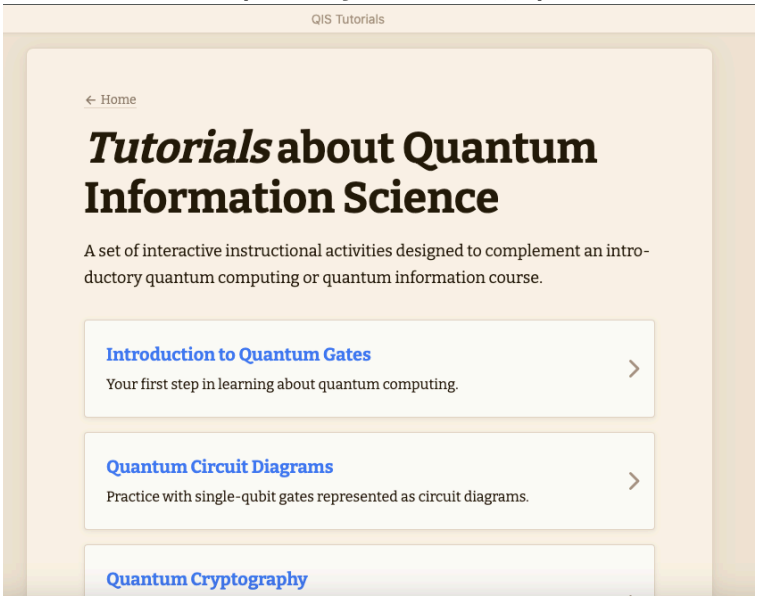
Consider the two-qubit state: $\frac{1}{\sqrt{3}}|00\rangle + \frac{\sqrt{2}}{\sqrt{3}}\, i\, |10\rangle$
What is the probability that a measurement on the second qubit will be a 0?

A. $\frac{\sqrt{2}}{\sqrt{3}}$
B. $\frac{1}{3}$
C. $\frac{2}{3}$
D. 1
E. Something else

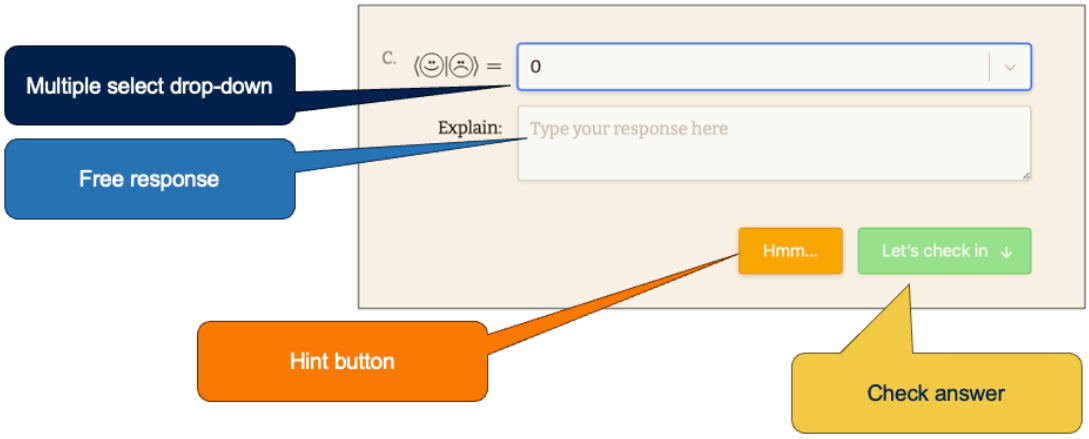
Consider the following expression: $\frac{1}{\sqrt{2}}(\,|0\rangle + |1\rangle\,) \otimes |1\rangle$
Which best describes the type of object this expression refers to?

A. The state of one qubit
B. The state of two qubits
C. The state of three qubits
D. Nonsense (this expression is not well-defined)
E. Other / not sure /....

Online Tutorials (AcePhysics.net/QIS)

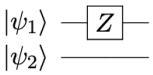


Sample of question formatting and features:



Sample from in-class tutorial worksheet (on Tensor Products)

Question A: Consider the following circuit.



Which represents the output state? (Select all correct expressions.)

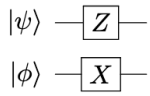
(a) $Z(|\psi_1\rangle \otimes |\psi_2\rangle)$

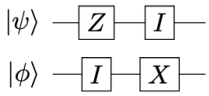
(b) $(Z\,|\psi_1\rangle) \otimes |\psi_2\rangle$

(c) $(Z \otimes I)(|\psi_1\rangle \otimes |\psi_2\rangle)$

(d) $(I \otimes Z)(|\psi_1\rangle \otimes |\psi_2\rangle)$

Consider the two circuit diagrams shown. Do you agree these two circuits are identical?



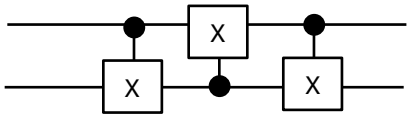


Question B: Consider the first I in the following expression: $(\mathbf{I} \otimes X)(Z \otimes I)(|\psi\rangle \otimes |\phi\rangle)$.

Which gate in the circuit above is that first (bolded) I referring to? (Circle it)

Homework questions

What does the following circuit do to each of the possible input computational basis states ($|00\rangle$, $|01\rangle$, $|10\rangle$, and $|11\rangle$)? Use this information to propose a useful name for this circuit.



NOTE: These three gates are all C_{NOT}'s, BUT the middle one is upside down, so Bit #2 is the control bit for that one.