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Courses » Quantum Information and Computing

Announcements **Course** Ask a Question Progress

Unit 2 - Week-1

Week 1 - Assignment 1

The due date for submitting this assignment has passed. **Due on 2017-08-07, 23:59 IST.**
As per our records you have not submitted this assignment.

In the following questions, ONLY ONE answer is correct. Choose the most appropriate one. (1X10=10 Marks)

1) Operators in quantum mechanics act on vectors in an abstract space called *1 point*

- Euclidean space
- Riemann space
- Hilbert space
- Normed space

No, the answer is incorrect.
Score: 0

Accepted Answers:
Hilbert space

2) Which of the following properties is **NOT** true of the abstract space in which quantum mechanics is formulated? *1 point*

- It has a norm.
- The space is complete.
- The space is a linear vector space.
- The operators corresponding to physical observables are represented by rays in this space.

No, the answer is incorrect.
Score: 0

Accepted Answers:
The operators corresponding to physical observables are represented by rays in this space.

3) Observables in quantum mechanics are represented by Hermitian operators because *1 point*

- They are linear.
- They have real eigenvalues.
- Acting on a vector of the Hilbert space, they give another vector in the same space.
- They may be represented by Hermitian matrices.

No, the answer is incorrect.
Score: 0

Accepted Answers:
They have real eigenvalues.

4) *1 point*

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The adjoint of an operator represented by the matrix $\begin{pmatrix} 1 & i \\ -i & 1 \end{pmatrix}$ is

- $\begin{pmatrix} 1 & i \\ -i & 1 \end{pmatrix}$
- $\begin{pmatrix} 1 & -i \\ i & 1 \end{pmatrix}$
- $\begin{pmatrix} 1 & 0 \\ 0 & 0 \end{pmatrix}$
- $\begin{pmatrix} i & 1 \\ -i & 1 \end{pmatrix}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\begin{pmatrix} 1 & i \\ -i & 1 \end{pmatrix}$

5) If u and v are two vectors in the Hilbert space and λ is a complex number, then, *1 point*

- $|u + v| \leq |u| + |v|$
- $\langle u, v \rangle = \langle v, u \rangle$
- $\langle \lambda u, v \rangle = \lambda \langle u, v \rangle$
- $\langle u, u \rangle > 0$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$|u + v| \leq |u| + |v|$

6) Where does the eigenvector of the Pauli operator σ_y corresponding to the eigenvalue -1 lie on the Bloch sphere? *1 point*

- $\theta = \frac{\pi}{2}, \varphi = 0$
- $\theta = \frac{\pi}{2}, \varphi = \frac{\pi}{2}$
- $\theta = \frac{\pi}{2}, \varphi = \pi$
- $\theta = \frac{\pi}{2}, \varphi = \frac{3\pi}{2}$

No, the answer is incorrect.
Score: 0

Accepted Answers:

7) Which of the following is a spectral representation of the matrix $\begin{pmatrix} -0.8 & 0.6 \\ 0.6 & 0.8 \end{pmatrix}$? *1 point*

- $\begin{pmatrix} -0.4 & 0.3 \\ 0.3 & 0.4 \end{pmatrix} - \begin{pmatrix} 0.4 & -0.3 \\ -0.3 & -0.4 \end{pmatrix}$
- $\begin{pmatrix} 0.1 & 0.3 \\ 0.3 & 0.9 \end{pmatrix} - \begin{pmatrix} 0.9 & -0.3 \\ -0.3 & 0.1 \end{pmatrix}$
- $\begin{pmatrix} 0.1 & -0.3 \\ -0.3 & 0.9 \end{pmatrix} - \begin{pmatrix} 0.9 & -0.9 \\ -0.9 & 0.1 \end{pmatrix}$
- $\begin{pmatrix} -0.1 & -0.3 \\ -0.3 & 0.9 \end{pmatrix} - \begin{pmatrix} -0.9 & -0.9 \\ 0.9 & -0.1 \end{pmatrix}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\begin{pmatrix} 0.1 & 0.3 \\ 0.3 & 0.9 \end{pmatrix} - \begin{pmatrix} 0.9 & -0.3 \\ -0.3 & 0.1 \end{pmatrix}$

8) Which of the following is **NOT** a hermitian operator? *1 point*

- x
- $-i\frac{\partial}{\partial x}$
- $\frac{p^2}{2m}$
- $x^2 + ix^3$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$x^2 + ix^3$

9) According to Copenhagen interpretation of quantum mechanics *1 point*

- A physical system does not have definite property independent of observation
- The value of a physical variable at a given time is definite but such value is revealed only at the time of measurement.
- The wave function collapse occurs when the laws of quantum mechanics do not remain valid.
- A quantum particle only has a discrete energy state.

No, the answer is incorrect.
Score: 0

Accepted Answers:
A physical system does not have definite property independent of observation

10) Which of the following matrices is **NOT** hermitian? *1 point*

- $\begin{pmatrix} 2 & 1+i & 2-i \\ 1-i & 1 & i \\ 2+i & -i & 1 \end{pmatrix}$
- $\begin{pmatrix} 1 & 1-i & 2 \\ 1+i & 3 & i \end{pmatrix}$

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$$\begin{pmatrix} i & 1-i & 2 \\ -1-i & 3i & i \\ -2 & i & 0 \end{pmatrix}$$

$$\begin{pmatrix} 3 & 2-i & -3i \\ 2+i & 0 & 1-i \\ 3i & 1+i & 0 \end{pmatrix}$$

No, the answer is incorrect.
Score: 0

Accepted Answers:

$$\begin{pmatrix} i & 1-i & 2 \\ -1-i & 3i & i \\ -2 & i & 0 \end{pmatrix}$$

In the following questions, ONE or MORE answer(s) is(are correct. Choose all the appropriate ones. (2X5=10 Marks)

11) Landauer's principle gives *2 points*

- A theoretical lower limit of the energy consumption in irreversible computation.
- A theoretical upper limit of the energy consumption in irreversible computation.
- Increase in entropy of the environment in an irreversible computation.
- Decrease in entropy of the environment in an irreversible computation.

No, the answer is incorrect.
Score: 0

Accepted Answers:
A theoretical lower limit of the energy consumption in irreversible computation.
Increase in entropy of the environment in an irreversible computation.

12) An acceptable wave function in quantum mechanics is *2 points*

- continuous everywhere
- single valued
- normalizable
- real valued

No, the answer is incorrect.
Score: 0

Accepted Answers:
continuous everywhere
single valued
normalizable

1.13) Which of the following set of vectors is (are) acceptable basis in $\mathbb{C}^3$? *2 points*

- $\begin{pmatrix} 1 \\ 0 \\ 1 \end{pmatrix}, \begin{pmatrix} 1 \\ 1 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 \\ 2 \\ -1 \end{pmatrix}$
- $\begin{pmatrix} 1 \\ 0 \\ 1 \end{pmatrix}, \begin{pmatrix} 0 \\ 1 \\ 1 \end{pmatrix}, \begin{pmatrix} 1 \\ 2 \\ -1 \end{pmatrix}$
- $\begin{pmatrix} 1 \\ 1 \\ 2 \end{pmatrix}, \begin{pmatrix} 2 \\ 2 \\ 5 \end{pmatrix}, \begin{pmatrix} 3 \\ 3 \\ 7 \end{pmatrix}$
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$\begin{pmatrix}1\\1\\0\end{pmatrix}, \begin{pmatrix}0\\1\\1\end{pmatrix}, \begin{pmatrix}1\\1\\1\end{pmatrix}$

No, the answer is incorrect.
Score: 0

Accepted Answers:

$\begin{pmatrix}1\\0\\1\end{pmatrix}, \begin{pmatrix}0\\1\\1\end{pmatrix}, \begin{pmatrix}1\\2\\-1\end{pmatrix}$

$\begin{pmatrix}1\\1\\0\end{pmatrix}, \begin{pmatrix}0\\1\\1\end{pmatrix}, \begin{pmatrix}1\\1\\1\end{pmatrix}$

14) Which of the following statements on unitary matrices is true? *2 points*

- [ ] A square matrix U is unitary if $UU^* = I$.
- [ ] If U is unitary U^{-1} also is unitary.
- [ ] Product of two unitary matrices is unitary.
- [ ] Eigenvalues of U are ± 1

No, the answer is incorrect.
Score: 0

Accepted Answers:
If U is unitary U^{-1} also is unitary.
Product of two unitary matrices is unitary.

15) Which of the following is an operator projecting a spin $\frac{1}{2}$ state along the eigenstate of σ_z corresponding to eigenvalue $+1$? *2 points*

- [ ] $\frac{(1+\sigma_z)^2}{2}$
- [ ] $\frac{(1-\sigma_z)^2}{2}$
- [ ] $\frac{(1+\sigma_z)^2}{4}$
- [ ] $\frac{(1-\sigma_z)^2}{4}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\frac{(1+\sigma_z)^2}{4}$

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