QUAID-I-AZAM UNIVERSITY, ISLAMABAD

M.PHIL ENTRY TEST PAPER (23RD JANUARY, 2014)

(A)

REGISTRATION NUMBER:________ NIC NUMBER:________________

FULL NAME:__________________________ SIGNATURE:__________________

M.Phil. Physics Admission Test

QUAID-I-AZAM UNIVERSITY
(DEPARTMENT OF PHYSICS)

January 23, 2014

Time: 2 hours

CANDIDATES NOT TO WRITE BELOW
NUMBER CORRECT =
NUMBER WRONG =
TOTAL MARKS =

- Answer all 25 questions or as many as you can.
- Each question carries equal marks. Circle only the right answer. If you do not know the answer, do not circle any answer.
- Circling two choices will be considered as a wrong answer.
- Wrong answers will be negatively marked (- 0.25 marks per mistakes).
- If you make a mistake, make your choice clear by writing out the correct answer in full or indicating it clearly. Marking two choices will be considered as a wrong answer.
- Any attempt to copy answers from another candidate will result in permanent disbarment from the university for all purposes.
- No books or calculators are allowed.

CIRCLE THE CORRECT ANSWER

Q.1	**A**	**B**	**C**	**D**	**E**
Q.2	**A**	**B**	**C**	**D**	**E**
Q.3	**A**	**B**	**C**	**D**	**E**
Q.4	**A**	**B**	**C**	**D**	**E**
Q.5	**A**	**B**	**C**	**D**	**E**
Q.6	**A**	**B**	**C**	**D**	**E**
Q.7	**A**	**B**	**C**	**D**	**E**
Q.8	**A**	**B**	**C**	**D**	**E**
Q.9	**A**	**B**	**C**	**D**	**E**
Q.10	**A**	**B**	**C**	**D**	**E**
Q.11	**A**	**B**	**C**	**D**	**E**
Q.12	**A**	**B**	**C**	**D**	**E**
Q.13	**A**	**B**	**C**	**D**	**E**

CIRCLE THE CORRECT ANSWER

Q.14	**A**	**B**	**C**	**D**	**E**
Q.15	**A**	**B**	**C**	**D**	**E**
Q.16	**A**	**B**	**C**	**D**	**E**
Q.17	**A**	**B**	**C**	**D**	**E**
Q.18	**A**	**B**	**C**	**D**	**E**
Q.19	**A**	**B**	**C**	**D**	**E**
Q.20	**A**	**B**	**C**	**D**	**E**
Q.21	**A**	**B**	**C**	**D**	**E**
Q.22	**A**	**B**	**C**	**D**	**E**
Q.23	**A**	**B**	**C**	**D**	**E**
Q.24	**A**	**B**	**C**	**D**	**E**
Q.25	**A**	**B**	**C**	**D**	**E**

(A)

Q1 Which of the following functions is an eigen function of the kinetic energy operator for a free particle of mass m in one-dimension?

(A) x

(B) x^2

(C) $\sin(kx)$

(D) $sin^2(kx)$

(E) $cos^2(kx)$

Q2 If the probability amplitude for a photon to be detected at an interferometer is $z = e^{i\alpha}(z_1 + z_2)$. How does the probability of the event depend on α?

(A) α^2 dependence

(B) α dependence

(C) α^3 dependence

(D) independent of α

(E) $\frac{1}{\alpha}$ dependence

(A)

Q3 For the wave function $\Psi(x,t) = Ae^{i(kx-\omega t)}$, the probability current is

(A) $\frac{\hbar k}{m}|A|^2$

(B) $\frac{\hbar k}{m}$

(C) $\frac{\hbar k}{m}|A|$

(D) $|A|^2$

(E) $\frac{m}{\hbar k}$

Q4 An electron has its spin pointed initially in the positive z direction. The x component of the spin is then measured. Then the z component is measured. What will your final measurement yield?

(A) $+\frac{\hbar}{2}$, with probability one

(B) $-\frac{\hbar}{2}$, with probability one

(C) 0, with probability one

(D) 1, with probability one

(E) $\pm\frac{\hbar}{2}$, with equal probability

(A)

Q5 The commutator of the Hamiltonian and the linear momentum operator of a free particle of mass m in one-dimension is

(A) $i\hbar$

(B) $\frac{\hbar}{2}$

(C) $\hbar$

(D) $\frac{\hbar}{4}$

(E) zero

Q6 A three-dimensional harmonic oscillator is in thermal equilibrium with a temperature reservoir at temperature T. The average total energy of the oscillator is

(A) $\frac{1}{2}k_BT$

(B) k_BT

(C) $\frac{3}{2}k_BT$

(D) $3k_BT$

(E) $6k_BT$

(A)

Q7 For two systems, A and B, that do not interact with each other, the partition function of the combined system can be written in terms of the partition functions of the individual systems as

(A) $Z = Z_A + Z_B$

(B) $Z = Z_A Z_B$

(C) $Z = \frac{Z_A}{Z_B}$

(D) $Z = Z_A - Z_B$

(E) $Z = \frac{Z_A + Z_B}{2}$

Q8 A sealed and thermally insulated container of total volume V is divided into two equal volumes by an impermeable wall. The left half of the container is initially occupied by n moles of an ideal gas at temperature T. Which of the following gives the change in entropy of the system when the wall is suddenly removed and the gas expands to fill the entire volume?

(A) $2nR \ln 2$

(B) $nR \ln 2$

(C) $\frac{1}{2} nR \ln 2$

(D) $-nR \ln 2$

(E) $-2nR \ln 2$

(A)

Q9 In a Maxwell-Boltzmann system with two states of energies ϵ and 2ϵ respectively, and a degeneracy of 2 for each state, the partition function is

(A) $e^{-\frac{\epsilon}{k_B T}}$

(B) $2e^{-\frac{2\epsilon}{k_B T}}$

(C) $2e^{-\frac{3\epsilon}{k_B T}}$

(D) $e^{-\frac{\epsilon}{k_B T}} + e^{-\frac{2\epsilon}{k_B T}}$

(E) $2e^{-\frac{\epsilon}{k_B T}} + 2e^{-\frac{2\epsilon}{k_B T}}$

Q10 Suppose that a system in quantum state i has energy E_i. In thermal equilibrium, the expression

$$\frac{\sum_i E_i e^{-E_i/k_B T}}{\sum_i e^{-E_i/k_B T}}$$

represents which of the following?

(A) The average energy of the system

(B) The partition function

(C) Unity

(D) The probability to find the system with energy E_i

(E) The entropy of the system

(A)

Q11 Maxwell's equations can be written in the form shown below. If magnetic charge exists and if it is conserved, which of these equations will have to be changed?

I $\nabla . E = \frac{\rho}{\epsilon_o}$

II $\nabla . B = 0$

III $\nabla \times E = -\frac{\partial B}{\partial t}$

IV $\nabla \times B = \mu_o J + \mu_o \epsilon_o \frac{\partial E}{\partial t}$

(A) I only

(B) II only

(C) III only

(D) I and IV

(E) II and III

Q12 Five positive charges of magnitude q are arranged symmetrically around the circumference of a circle of radius r. What is the magnitude of the electric field at the center of the circle? $\left(k = \frac{1}{4\pi\epsilon_o}\right)$

(A) 0

(B) $\frac{kq}{r^2}$

C) $\frac{5kq}{r^2}$

(D) $\frac{kq}{r^2}\cos\left(\frac{2\pi}{5}\right)$

(E) $\frac{5kq}{r^2}\cos\left(\frac{2\pi}{5}\right)$

(A)

Q13 Consider two infinite wires at a distance d apart and each carrying current I in the same direction. If the current in each wire is doubled and so is the separation between the two wires then the force per unit length between the two wires will

(A) Remain the same
(B) Increase by a factor of two
(C) Decrease by a factor of two
(D) Increase by a factor of four
(E) Decrease by a factor of four

Q14 Consider a parallel plate capacitor carrying surface charge density $\pm\sigma$, the magnitude of the electric field inside the capacitor is

(A) zero

(B) $\frac{2\sigma}{\epsilon_o}$

(C) $\frac{[illegible]}{\epsilon_o}$

(D) $\frac{\sigma}{2\epsilon_o}$

(E) $\frac{\sigma}{\epsilon_o}$

(A)

Q15 The electric field intensity at the centre (r = 0) of a uniform spherical charge distribution is

(A) ∞

(B) 0

(C) finite but non-zero

(D) approaches to infinity

(E) depends on the radius of the sphere

Q16 The Lagrangian for a mechanical system is

$$L = a\dot{q}^2 + bq^4$$

where q is a generalized coordinate and a and b are constants. The equation of motion for this system is

(A) $\dot{q} = \sqrt{\frac{b}{a}}q^2$

(B) $\dot{q} = \frac{2b}{a}q^3$

(C) $\ddot{q} = -\frac{2b}{a}q^3$

(D) $\ddot{q} = +\frac{2b}{a}q^3$

(E) $\ddot{q} = \frac{b}{a}q^3$

(A)

Q17 When a particle oscillates in simple harmonic motion, both its potential and kinetic energy vary sinusoidally with time. If ω is the frequency of the particle's motion, the kinetic energy oscillates with frequency

(A) $4\,\omega$

(B) $2\,\omega$

(C) ω

(D) $\frac{1}{2}\omega$

(E) $\frac{1}{4}\omega$

Q18 The escape velocity for a particle on a spherical planet of radius R and mass M is

(A) $\sqrt{\frac{2GM}{R}}$

(B) $\sqrt{\frac{GM}{R}}$

(C) $\frac{\sqrt{2GM}}{R}$

(D) $\frac{\sqrt{GM}}{R}$

(E) $\sqrt{\frac{2GM}{3R}}$

(A)

Q19 The acceleration a and the tension T for an Atwood's machine with equal masses $m_1 = m_2 = m$ are

(A) $(T, a) = (mg, g/2)$

(B) $(T, a) = (mg, g)$

(C) $(T, a) = (mg, 0)$

(D) $(T, a) = (2mg, 0)$

(E) $(T, a) = (0, 0)$

Q20 A small sphere attached to the end of a string swings as a simple pendulum. Which of the following remains constant during the motion of the sphere?

(A) Accelertaion

(B) Total energy

(C) Potential energy

(D) Kinetic energy

(E) Velocity

(A)

Q21 Evaluate $\oint_C z^* dz$ around the circle $|z| = 1$

(A) 0

(B) $2i\pi$

(C) -1

(D) $-i\pi$

(E) 1

Q22 Expand $\frac{1}{1+x}$ about $x = 1$

(A) $\frac{1}{2} + \frac{(x-1)}{3} + \frac{(x-1)^2}{4} + \cdots$

(B) $\frac{1}{2} - \frac{(x-1)}{4} + \frac{(x-1)^2}{4} + \cdots$

(C) $\frac{1}{2} - \frac{(x-1)}{4} - \frac{(x-1)^2}{8} + \cdots$

(D) $\frac{1}{2} - \frac{(x-1)}{4} + \frac{(x-1)^2}{8} + \cdots$

(E) $\frac{1}{2} - \frac{(x-1)}{4} - \frac{(x-1)^2}{4} + \cdots$

(A)

Q23 Evaluate $\int_{-1}^{3}\left(\frac{\mathrm{d}\delta(x)}{\mathrm{dx}}\right)dx$

(A) 1

(B) 0

(C) -1

(D) 4

(E) −4

Q24 Find the solution of $\ddot{r}(t) - 16\,r(t) = 0$ with the boundary conditions $r(0) = r_0$ & $\dot{r}(0) = 0$

(A) $r_0(1+\sin(4t))$

(B) $r_0\cos(4t)$

(C) $r_0(e^{4t} + e^{-4t})$

(D) $r_0(e^{4t} - e^{-4t})$

(E) $r_0\cosh(4t)$

(A)

Q25. For a particle moving in a circular orbit $\vec{r} = r(\hat{x}\cos\omega t + \hat{y}\sin\omega t)$, evaluate $\vec{r} \times \dot{\vec{r}}$

(A) $\omega \vec{r}$

(B) $\omega r^2 \hat{z}$

(C) $2\omega r^2 \hat{z}$

(D) $\omega \vec{r}$

(E) 0