(A)

REGISTRATION NUMBER:________ NIC NUMBER:________________

FULL NAME:________________________ SIGNATURE:________________

M.Phil. Physics Admission Test

QUAID-I-AZAM UNIVERSITY
(DEPARTMENT OF PHYSICS)

August 22, 2013

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 Degeneracy to an energy eigenstate can be best described by saying

A. An energy eigenstate has at least two different energies.
B. Two or more particle states have zero linear momentum.
C. Two or more different states of a particle have the same energy.
D. Two are more particle states have zero angular momentum.
E. All above statements are incorrect.

Q2 The energy required to remove both electrons from the helium atom in its ground state is 79.0 eV. How much energy is required to ionize helium (i.e., to remove one electron)?

A. 24.6 eV
B. 39.5 eV
C. 51.8 eV
D. 54.4 eV
E. 65.4 eV

(A)

Q3 The eigenvalues of a Hermitian operator are always

A. Real.

B. Imaginary.

C. degenerate.

D. linear.

E. positive.

Q4 The components of the orbital angular momentum operator $L = (L_x, L_y, L_z)$ satisfy the following commutation relations.

$[L_x, L_y] = i\hbar L_z$

$[L_y, L_z] = i\hbar L_x$

$[L_z, L_x] = i\hbar L_y$

What is the value of the commutator $[L_x L_y, L_z]$?

A. $2i\hbar L_x L_y$

B. $i\hbar(L_x^2 + L_y^2)$

C. $-i\hbar(L_x^2 + L_y^2)$

D. $i\hbar(L_x^2 - L_y^2)$

E. $-i\hbar(L_x^2 - L_y^2)$

(A)

Q5 The wave function for identical fermions is antisymmetric under particle interchange. Which of the following is a consequence of this property?

A. Heisenberg uncertainty principle

B. Bose-Einstein condensation

C. Bohr correspondence principle

D. Fermi's golden rule

E. Pauli exclusion principle

Q6 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)

Q7 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 Z is

A. $Z = e^{-\frac{\varepsilon}{kT}}$

B. $Z = 2e^{-2\varepsilon/kT}$

C. $Z = 2e^{-\frac{3\varepsilon}{kT}}$

D. $Z = e^{-\frac{\varepsilon}{kT}} + e^{-\frac{2\varepsilon}{kT}}$

E. $Z = 2[e^{-\frac{\varepsilon}{kT}} + e^{-\frac{2\varepsilon}{kT}}]$

Q8 A black body at temperature T_1 radiates energy at a power level of 10 milliwatts (mW). The same blackbody, when at temperature $2T_1$, radiates energy at a power level of

A. 10 mW

B. 20 mW

C. 40 mW

D. 160 mW

E. 80 mW

(A)

Q9 One feature common to both the Debye theory and Einstein theory of the specific heat of a crystal composed of N atom is that the

A. average energy of each atom is 3kT.
B. crystal is assumed to be continuous for all elastic waves.
C. vibrational energy of the crystal is equivalent to the energy of 3N independent harmonic oscillators.
D. speed of the longitudinal elastic waves is less than the speed of the transverse elastic waves.
E. upper cutoff frequency of the elastic waves is the same.

Q10 For an ideal gas, the specific heat at constant pressure C_p is greater than the specific heat at constant volume C_v because.

A. Gas does work on environment when its pressure remains constant while its temperature is increased.
B. Heat input per degree increase in temperature is the same in processes for which either the pressure or the volume is kept constant.
C. Pressure of the gas remains constant when its temperature remains constant.
D. Increase in the gas's internal energy is greater when the pressure remains constant than when the volume remains constant.
E. Heat needed is greater when the volume remains constant than when the pressure remains constant.

(A)

Q11 A sphere of mass m is released from rest in a stationary viscous medium. In addition to the gravitational force of magnitude mg, the sphere experiences a retarding force magnitude bv, where v is the speed of the sphere and b is a constant. Assume that the buoyant force is negligible. Which of the following statements about the sphere is correct?

A. Its kinetic energy decreases due to retarding force.

B. Its kinetic energy increases to a maximum, then decreases to zero due to the retarding force.

C. Its speed increases to a maximum, then decreases back to a final terminal speed.

D. Its speed increases monotonically, approaching a terminal speed that depends on b but not on m.

E. Its speed increases monotonically, approaching a terminal speed that depends on both b and m.

Q12 Consider a satellite of mass m moving in a circular orbit around the earth at a constant speed v and at an altitude h above the earth's surface. The speed of the satellite in terms of gravitational constant, G, h, the radius of the earth, R_E and the mass of earth, M_E, is:

A. $\sqrt{\frac{GM_E}{R_E+h}}$

B. $\sqrt{\frac{GM_E}{R_E}}$

C. $\sqrt{\frac{GM_E}{h}}$

D. $\sqrt{\frac{GmM_E}{R_E+h}}$

E. $\sqrt{\frac{GmM_E}{2h}}$

(A)

Q13 Consider the case of projectile motion. Mass of the projectile is m. Lagrangian of the system is given by:

A. $\frac{1}{2}m\dot{y}^2 - mgy$

B. $\frac{1}{2}m\dot{x}^2 - mgy$

C. $\frac{1}{2}m\dot{x}^2+\frac{1}{2}m\dot{y}^2$

D. $\frac{1}{2}m\dot{x}^2+\frac{1}{2}m\dot{y}^2 - mgy$

E. $\frac{1}{2}m\dot{x}^2 + mgy$

Q14 A ball of mass m is dropped from a height h above the ground. Neglecting air resistance, determine the speed of the ball when it is at a height y above the ground.

A. $\sqrt{2g(y-h)}$

B. $\sqrt{2g(h-y)}$

C. $\sqrt{2g(h-y)}$

D. $\sqrt{2gh}$

E. $\sqrt{2gy}$

(A)

Q15 A 6.0-kg block initially at rest is pulled to the right along a frictionless, horizontal surface by a constant horizontal force of 12 N. The block's speed after it has moved 3.0 m is nearly equal to:-

A. 2.45m/s
B. 3.5m/s
C 1.33m/s
D. 2m/s
E. 7.0 m/s

Q16 The electric potential at the center of a spherical shell of radius R and charge Q is

A. Zero
B. Infinite
C. $\frac{Q}{4\pi\epsilon_0 R}$
D. $\frac{2Q}{4\pi\epsilon_0 R}$
E. $\frac{Q}{8\pi\epsilon_0 R}$

(A)

Q17 An isolated conducting sphere of radius R has a charge Q. The radius r within which half the stored energy is contained is given by

A. R

B. $2R$

C. $\frac{3}{2}R$

D. $\frac{5}{2}R$

E. $\frac{7}{2}R$

Q18 A coil of N turns and area A rotates with a frequency ω about a diameter that is perpendicular to a uniform magnetic field B. The peak emf induced in the coil is

A. $\frac{1}{2}\omega BNA$

B. $\frac{3}{2}\omega BNA$

C. $2\omega BNA$

D. $3\omega BNA$

E. ωBNA

(A)

Q19 An electromagnetic waveis propagating in the $\hat{z}$ direction as described by the electric field

$$\mathbf{E} = E_1 \cos(kz - \omega t)\,\hat{x} + E_2 \cos(kz - \omega t + \delta)\hat{y}$$

Which of the following is a false statement?

A. This will be a circular polarized wave for $E_1 = E_2$ and $\delta = \pi/2$
B. This will be a linear polarized wave for $E_1 = E_2$ and $\delta = 0$
C. This will be a linear polarized wave for $E_1 \neq E_2$ and $\delta = \pi$
D. This will be an elliptically polarized wave for $E_1 = E_2$ and $\delta = \pi/4$
E. This will be an elliptically polarized wave for $E_1 = E_2$ and $\delta = 3\pi/2$

Q20 Two identical conducting spheres, *A* and *B*, carry equal charge. They are initially separated by a distance much larger than their diameters, and the force between them is **F**. A third identical conducting sphere, *C*, is uncharged. Sphere *C* is first touched to *A*, then to *B*, and then removed. As a result, the force between *A* and *B* is equal to

A. 0
B. **F**/16
C. **F**/4
D. 3**F**/8
E. **F**/2

(A)

Q21 Evaluate $\int_C z^* dz$, where C is a straight line joining the points $z = 0$ and $z = 1 + i$

A. 0
B. i
C. -1
D. $-i$
E. 1

Q22 Find the eigenvalues of the following matrix

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

A. 2, 1, 0
B. 4, 0, 0
C. 2, 2, 0
D. 0, 1, 3
E. $0, -2, -2$

(A)

Q23 Evaluate

$$\int_{0}^{-3} \delta\,(2\,x+1)\,dx$$

A. $\frac{1}{2}$

B. $-\frac{1}{2}$

C. 0

D. 1

E. -1

Q24 $(\vec{r}\cdot\vec{\nabla})\,\vec{r}$ can be written as

A. $\vec{\boldsymbol{r}}$

B. $\hat{r}$

C. $\vec{\nabla}r^2$

D. r

E. 0

(A)

Q25 Solve the initial value problem

$$\frac{dy}{dx} = ky, \qquad y(0) = 2$$

A. $y = e^{-kx}$

B $y = e^{kx}$

C. $y = xe^{kx}$

D. $y = 2e^{kx}$

E. $y = e^{2kx}$

GOOD LUCK