QUAID-I-AZAM UNIVERSITY, ISLAMABAD

M.PHIL ENTRY TEST PAPER (01ST FEBRUARY, 2011)

(B)

REGISTRATION NUMBER:________ NIC NUMBER:_______________

FULL NAME:_______________________ SIGNATURE:________________

M.Phil. Physics Admission Test

QUAID-I-AZAM UNIVERSITY
(DEPARTMENT OF PHYSICS)

February 01, 2011

Time: 90 Minutes

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

- Answer all 20 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

CIRCLE THE CORRECT ANSWER

Q.11	A	B	C	D	E
Q.12	A	B	C	D	E
Q.13	A	B	C	D	E
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

1- A body of mass m accelerates uniformly from rest to speed u in time T. Then the instantaneous power delivered to the body as a function of time t is given by

A) $\frac{1}{2}\frac{mu^2}{T^2}t$

B) $\frac{1}{2}\frac{mu^2}{T^2}t^2$

C) $\frac{mu^2}{T^2}t$

D) $\frac{mu^2}{T^2}t^2$

E) $2\frac{mu^2}{T^2}t$

2- If the gravitational force of attraction between any two bodies depends on $\frac{1}{R^3}$ instead of $\frac{1}{R^2}$ and is directly proportional to the masses of the bodies, then the period of the planet round the Sun, in a circular orbit, will be proportional to

A. mR

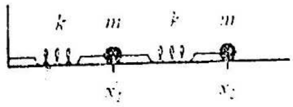
B. R^3

C. $R^{1.5}$

D. R^{-2}

E. R^2

Q.3. Two point-masses are connected by a spring. The left mass is also connected to a support by a spring. Both masses are confined to move on a frictionless horizontal surface. The masses are each m and the spring constants are both k. Take the unstretched lengths of both springs to be zero. Choosing the generalized coordinates x_1 and x_2 as in the fig., the Lagrangian for this system is:



A. $\frac{1}{2}m(\dot{x}_1^2+\dot{x}_2^2)-\frac{1}{2}k(x_2-x_1)^2$

B. $\frac{1}{2}m(\dot{x}_1^2+\dot{x}_2^2)-\frac{1}{2}k(x_1^2+x_2^2)$

C. $\frac{1}{2}m(\dot{x}_1^2+\dot{x}_2^2)-\frac{1}{2}kx_1^2-\frac{1}{2}k(x_2-x_1)^2$

D. $\frac{1}{2}k(x_2-x_1)^2$

E. 0

Q.4. Consider a system of mass m with just one generalized coordinate q with the Lagrangian

$L = exp^{bt}\left(\frac{1}{2}m\dot{q}^2 - \frac{1}{2}kq^2\right)$ where b and k are positive constants and t is the time. For this system the equation of motion is

A. $m\dot{q}^2 - kq^2 = 0$
B. $m\,exp^{bt}\,\ddot{q} = 0$
C. $m\ddot{q} + bm\dot{q} + kq = 0$
D. $m\ddot{q} + kq = 0$
E. $m\ddot{q} + bm\dot{q} = 0$ =

B

Q.5. A solid cylinder of mass M (moment of inertia $I = \frac{1}{2}MR^2$) and radius R rolls without slipping down an inclined plane of length L and height h. The speed of its centre of mass when the cylinder reaches the bottom is,

A. $\sqrt{\frac{gh}{3}}$

B. $\sqrt{\frac{4gh}{3}}$

C. $\sqrt{\frac{4gh}{13}}$

D. $\sqrt{\frac{4gh}{3I}}$

E. $\sqrt{\frac{4gRh^2}{3}}$

6. Solution of the integral $I = \int_{-\infty}^{\infty} \exp\left[iax - bx^2\right] dx$ where a and b are real numbers, gives

A. $\sqrt{\frac{\pi}{b}}$

B. $\sqrt{\frac{\pi}{ab}}$

C. $\sqrt{\frac{\pi}{a}} \exp\left[-\frac{a^2}{4b}\right]$

D. $\sqrt{\frac{\pi}{b}} \exp\left[-\frac{a^2}{4b}\right]$

E. $\sqrt{\frac{\pi}{b}} \exp\left[\frac{a^2}{4b}\right]$

Q.7. The value of the contour integral $\oint \frac{\sin 3z}{\left(z+\frac{\pi}{2}\right)} dz$ for $|z|=5$ is

A. 0

B. $2\pi i$

C. $\frac{3\pi i}{2}$

D. $\pi/3$

E. π

Q.8. A spin half particle is described by the spinor $\chi = \sqrt{\frac{2}{3}}\begin{pmatrix}1\\0\end{pmatrix}+\sqrt{\frac{1}{3}}\begin{pmatrix}0\\1\end{pmatrix}$.

On making measurements of the z-component of the spin, which of the following will be true?

A. spin up and spin down would be found with equal probability
B. z component of the spin cannot be measured in this state
C. probability of spin down is twice that of spin down
D. probability of spin up is twice that of spin down
E. probability of spin down is $\sqrt{\frac{2}{3}}$ times the probability of spin up.

Q.9. At time $t = 0$, a particle in a harmonic oscillator potential $V(x) = \frac{1}{2}m\omega^2 x^2$ has a wave function $\psi = c\psi_0 + d\psi_1$ where c and d are complex numbers and ψ_0, ψ_1 are the normalized ground state and the first excited state wave functions of the harmonic oscillator, respectively. The probability of measuring the particle's energy to be $\hbar\omega$ is

A. 1

B. 0

C. 1/2

D. 1/3

E. 1/4

Q.10. Given a particle in a state $\psi(x)= x\ exp^{-x}$, where is the particle most likely to be found?

A. at x=0

B. at both x=0.5 and x=0

C. at both x=1.0 and x=0

D. at both x=2 and x=0

E. at x=2

Q.11. At time t=0 a particle is in the state $\psi(0) = a\varphi_1 + b\varphi_2$ where φ_1 and φ_2 are the eigen states of the system with energies E_1 and E_2 respectively. At a subsequent time t, the state of the system would be given by

A. $\psi(t) = t\,(a\varphi_1 + b\varphi_2)$

B. $\psi(t) = exp^{-it\left(\frac{E_1+E_2}{\hbar}\right)}(a\varphi_1 + b\varphi_2)$

C. $\psi(t) = (a\varphi_1 exp^{-it\left(\frac{E_1}{\hbar}\right)} + b\varphi_2 exp^{-it\left(\frac{E_2}{\hbar}\right)})$

D. $\psi(t) = (at\,\varphi_1 exp^{-it\left(\frac{E_1}{\hbar}\right)} + bt\,exp^{-it\left(\frac{E_2}{\hbar}\right)}\varphi_2)$

E. $\psi(t) = (a\varphi_1 exp^{+it\left(\frac{E_1}{\hbar}\right)} + bt\,exp^{+it\left(\frac{E_2}{\hbar}\right)}\varphi_2)$

Q.12. For a harmonic oscillator of mass m and angular frequency ω at temperature T, the quantum mechanical partition function is

A. $\dfrac{1}{2Sinh\left(\dfrac{\hbar\omega}{2kT}\right)}$

B. $exp^{\frac{\hbar\omega}{kT}}$

C. $exp^{\frac{-\hbar\omega}{kT}}$

D. $2\,Cosh\left(\dfrac{\hbar\omega}{kT}\right)$

E. $\dfrac{\hbar\omega}{kT}$

(where k is Boltzmann's constant)

B

Q.13. Given that the atmosphere has a uniform temperature T at all heights, in the earth's gravitational field g, the relative probability of finding a molecule of mass m at a height h_2 compared to h_1 would be

A. $\frac{h_2}{h_1}$

B. $(h_2 - h_1)/(h_1+h_2)$

C. $exp^{-\frac{mg(h_2-h_1)}{kT}}$

D. $\frac{h_1}{h_2}$

E. $exp^{+\frac{mg(h_2-h_1)}{kT}}$

Q.14. An ideal gas at temperature T and pressure P expands adiabatically from a volume V to 4V. The final pressure, after expansion, would be: (defining $\gamma \equiv C_p/C_v$)

A. $P_f = \frac{P}{4}\left(\frac{1}{4}\right)^{\gamma-1}$

B. $P_f = P^{\gamma}$

C. $P_f = P4^{\gamma}$

D. $P_f = 4PT^{\gamma}$

E. $P_f = 4P(\gamma - 1)$

Q.15. If the energy required to create a single defect in a crystal of N sites is given as ε while the number of ways of distributing the n defects amongst the N sites is $\frac{N!}{n!(N-n)!}$ the free energy F of the system is equal to

A. $n\varepsilon - \frac{k_B T N!}{n!(N-n)!}$

B. $n\varepsilon - \frac{k_B T N!}{n!}$

C. $n\varepsilon - \frac{k_B}{T} \ln\left(\frac{N!}{n!(N-n)!}\right)$

D. $n\varepsilon - k_B T \ln\left(\frac{N!}{n!(N-n)!}\right)$

E. $\varepsilon - k_B T \ln\left(\frac{N!n!}{(N-n)!}\right)$

Q.16. A particle of charge q travelling with constant speed along the x-axis enters a region where there is a uniform magnetic field B along the z-axis. The y component of the particle's momentum would

A. be zero for all times

B. be nonzero but a constant for all tim

C. would change at the rate $-q(v_y B)$

D. would change at the rate $+q(v_x B)$

E. would change at the rate $-q(v_x B)$

B

(17) A coil of area A is placed in a magnetic field that varies with time as $B=B_o \cos(\omega t)$. If the frequency (ω) of the field is doubled (2ω) while the area (A) of the coil is halved (A/2), the magnitude and frequency of the induced electric field change as follows:

A. both remain the same
B: the magnitude increases four times while the frequency remains unchanged
C. the magnitude remains the same but frequency is doubled,
D the magnitude is halved but the frequency is doubled
E. both magnitude and frequency are doubled

Q.18. If the electric field in some region of space has the three components E $(0,y^2,0)$ then the correct statement is

A. There is a time varying B field
B. There is a charge density
C. The electric field cannot be expressed in this way
D. The electric field is time dependant
E. The field has a non zero curl

Q.19. A conducting spherical shell of radius R carries a charge +Q and is surrounded by another concentric conducting shell of radius 2R carrying a charge –Q. The electric fields outside (r>2R) and between the two spheres (R<r<2R) are

A. zero outside and zero between them.

B. $\frac{Q}{4\pi\epsilon_0 R^2}$ outside the spheres and zero between them.

C. $\frac{Q}{4\pi R^2}$ outside the spheres and zero inside.

D. zero outside and $\frac{Q}{4\pi\epsilon_0 r^2}$ between the two spheres.

E. $\frac{Q}{4\pi\epsilon_0 r^2}$ both outside and between the spheres

Q.20. In a region of space both electric field (E) and magnetic fields (B) are present where they are parallel to each other. If the magnitudes of both fields are doubled, while their directions are made perpendicular to each other, the total electromagnetic energy

A. Remains unchanged
B. Becomes 4 times the initial value
C. Becomes double of the initial value
D. Becomes one half of the initial value
E. Becomes zero