(a) Is the wavefunction $\Psi(x,t)$ normalised ?

(b) Find $\Psi(x,t)$. $2^1/_2+2^1/_2$

14. (a) What is Parity ? Find the eigen values of parity operator. 1+1

(b) Find $[x, p_x]$ and $[Lx, x]$. 3

—— X ——

Ex/B.Sc/PHY/22/HO8/64/2019(OLD)

BACHELOR OF SCIENCE EXAMINATION, 2019

(2nd Year, 2nd Semester, Old Syllabus)

PHYSICS (HONOURS)

Paper : HO-8

Time : Two hours Full Marks : 50

Use separate answer script for each group.

The figures in the margin indicate full marks.

GROUP - A (25 marks)
(Special Theory of Relativity)
Answer any ***five*** questions.

1. (a) An observer casts a laser pulse of frequency $\nu = 10^{15}$ Hz against a mirror, which is moving with a speed $\upsilon = 5 \times 10^7$ m/s opposite to the direction of the pulse, and whose surface is orthogonal to it. The observer then measures the frequency ν of the pulse coming back after being reflected by the mirror. What is the value of ν ?

(b) A galaxy in the constellation Ursa Major is receding from the earth at 15,000 km/s. If one of the characteristic wavelengths of the light the galaxy emits is 550 nm, what is the corresponding wavelength measured by astronomers on the earth ? 3+2

2. (a) If an electron has a speed of 99.0% that of light, what are its total energy, kinetic energy, and momentum? The rest mass energy of electron is 0.511 MeV.

   (b) A body at rest spontaneously breaks up into two parts which move in opposite directions. The parts have rest masses of 3 kg and 5.33 kg and respective speeds of 0.8c and 0.6c. Find the rest mass of the original body. 3+2

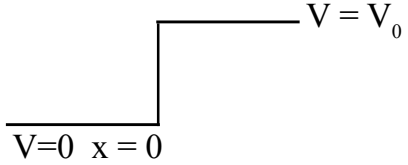
3. A nucleus of mass *m* emits a gamma ray photon of frequency *v* Show that the loss of internal energy of the nucleus is given by

$$\Delta E = hv\left[1+\frac{hv}{2mc^2}\right]$$ 5

4. The speed of light in still water is $\frac{c}{n}$, where the index of refraction for water is approximately $n=\frac{4}{3}$. Fizeau, in 1851, found that the speed (relative to the laboratory) of light in water moving with a speed V (relative to the laboratory) could be express as

$$u=\frac{c}{n}+kV$$

10. A particle of mass moving along positive direction of x axis and approach a potential barrier as shown below.



Energy of the particle E is greater than V_0($E > V_0$). Show that the sum of reflection coefficient and transmission coefficient is 1. 5

11. Write down Schrodinger wave equation in one dimension. What is the condition to get stationary state ? Find the expression of time independent Schrodinger equation. 1+1+3

12. (a) Show that $< p_x >$ is real

    (b) Show that $\frac{d}{dt}< x >=\frac{< p_x >}{m}$ 2+3

13. A harmonic oscillator is in a state described by the wavefuncion

$$\psi(x,t)=\frac{1}{2}\,\psi_0(x)+\frac{i}{2}\,\psi_1(x)+\frac{1}{\sqrt{2}}e^{i\pi/3}\,\psi_2(x)$$

where $\Psi_n(x)$ are normalised wave function.

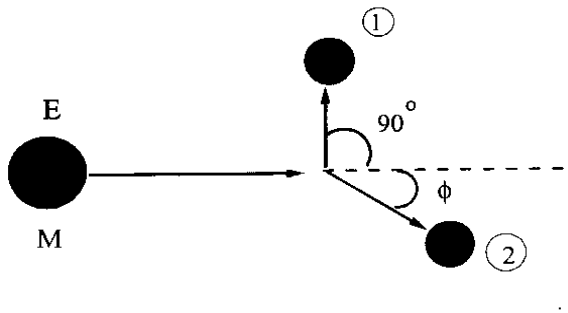


Figure 1

GROUP - B

Answer any ***five*** questions.

8. (a) Write down uncertainty Principle of Heisenberg. 2

   (b) What are the de Broglie wavelengths of a particle of mass 1 gm moving with velocity 300 m/s and that of an electron moving with velocity 300 m/s. 3

9. (a) A particle of mass m is confined in a potential well given by

   $V = 0 \quad 0 < x < 0$

   $= \alpha$ elsewhere. 3+4+1

   Find the energy states and interprete the result. Find wave function (normalised). 5

where the "dragging coefficient" was measured by him to be $k \approx 0.44$. Determine the value of k predicted by the Lorentz velocity transformations. 5

5. (a) At what velocity the relativistic kinetic energy differ from the classical energy by 10%.

   (b) At what speed the kinetic energy of a particle is n times its rest energy?

   (c) If the total energy of a particle is n times its rest energy, what is its momentum? [2+1+2]

6. A particle moves with a speed of 0.8c at an angle of 30° to the x-axis, as determined by observer O. Suppose a second observer O' which is moving with a speed of – 0.6c along the common $x - x'$. axis.

   (i) What is the velocity of the particle as determined by the second observer O'?

   (ii) How much the angle the velocity makes with x' axis? 3+2

7. A particle with mass M and energy E decays into two identical particles. In the lab frame, they are emitted at angles 90° and ϕ as shown in Figure 1. What are the energies of the created particles? 5