BACHELOR OF SCIENCE EXAMINATION, 2019

(2nd Year, 1st Semester)

PHYSICS (HONOURS)

Paper : CORE - 7

Time : Two hours Full Marks : 50

Use a separate answer script for each group.

GROUP - A

Answer any ***five*** questions. 5x5=25

1. Show that the intensity of light coming from a plane wave front is proportional to the square of the half displacement of the first half period zone. Hence, justify the rectilinear propagation of light ray. 4+1

2. What do you mean by angular dispersion of a grating ? Show that angular dispersion of grating depends on the number of grating elements(N) and the order number of the spectrum (n). Cmpare angular dispersion between grating and prism. 1+3+1

3. Write down the different uses of Michelson's interfrometer. Discuss how it is used to determine the difference of wavelengths between two close spectral lines. 1+4

4. Deduce Lorentz's formula for normal dispersion on the basis of electromagnetic theory. 5

5. "Light wave is transverse in nature" justify your answer by a simple experiment. State and prove Brewster's law in polarization. 2+1+2

6. Why are Optical fibres so important in modern communication system? Determine the acceptance angle of a Step-index optical fibre. Write down the various applications of Optical fibres. 1+2+2

7. Consider an optical fibre of diameter 50 μm. If the refractive index of the core is 1.6, then find the number of reflections that a ray incident at an angle 30° will suffer in travelling through 1 m of the fibre. 5

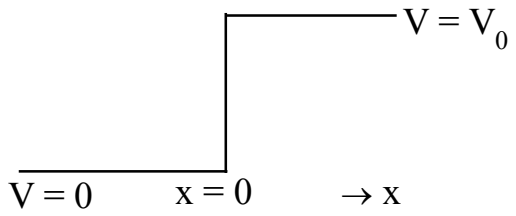
8. The objective of a telescope has the diameter of 100 inches and focal length 5 m. Assuming the mean wavelength of the incident beam to be 6000 Å, calculate the least angular separation of two distant stars that can be resolved by the telescope. Also determine the linear separation between the images of the two stars at the focal plane of the objective. 5

15. (a) Show that if the particle is in a stationery state at a given time, it will always remain stationery. 2

(b) $\psi(n) = A\left(\frac{x}{x_0}\right)^n e^{-x/x_0}$ where A, n and x_0 are constant. Find v(x) and energy E for which the wave function is an eigen function. Assume as x $\rightarrow \alpha$, v(x) = 0. 2+1

—— X ——

12. Consider the movement of a particle of mass 'm' with energy E form Left to right to cross the following step potential :



If $E > V_0$ show that the sum of reflection coefficient and Transmission coefficient is 1. 5

13. (a) Write down the basic postulates of wave mechanics.

(b) Find the probability current density $S(\vec{r}, t)$ for a wave function $\psi = \frac{e^{ikr}}{r}$ where $r = \sqrt{x^2 + y^2 + z^2}$. 2+3

14. (a) What are the significance of operators

$$a = \frac{1}{\sqrt{2m\hbar\omega}}(m\omega x + ip), \quad a^+ = \frac{1}{\sqrt{2m\hbar\omega}}(m\omega x - ip)$$

for LHo. Express H interms of a and a^+. 2+2

(b) Find [a, H]. 1

GROUP - B

Answer any ***five*** questions.

9. Discuss Heisenberg's uncertainty principle. An electron is confined to a box of length 10^{-8}cm. Calculate the minimum uncertainty in its velocity. (Given m(rest mass) = 9.1 x 10^{-28} gm h = 6.62 x 10^{-27} erg sec.) 3+2

10. Show that following commutation relations

(i) $\left[x, p_x^n\right] = i\hbar n p_x^{n-1}$

(ii) $\left[L_x, L_y\right] = i\hbar L_z$

(iii) $\left[x, L_z\right] = -i\hbar y$ $1^1/_2+2+1^1/_2$

11. A particle is described by the wave function $\psi(x,0) = \sqrt{\frac{1}{6}}\,\psi_1 + \frac{i}{\sqrt{2}}\,\psi_2(x) + \sqrt{\frac{1}{3}}\,\psi_3(x)$ where it is confined is an infinite potential well of width a between x= 0 to x = a what does it mean ? How the state will evolve with time ? Find average energy. $1+2^1/_2+1^1/_2$