SUBJECT CODE :15PH/MC/QR64

B.Sc. DEGREE EXAMINATION APRIL 2019
BRANCH III - PHYSICS
SIXTH SEMESTER

COURSE   :   MAJOR – CORE
PAPER   :   QUANTUM MECHANICS AND RELATIVITY
TIME   :   3 HOURS   MAX. MARKS :100

SECTION – A

ANSWER ALL QUESTIONS: (30 x 1 = 30)
I   CHOOSE THE CORRECT ANSWER:

1. A proton and an α - particle are accelerated through the same potential difference. The ratio of their de-Broglie wavelengths $\left(\lambda p / \lambda_\alpha \right)$ is

    a)   1   b)   2   c) $\sqrt{8}$ d) $\dfrac{1}{\sqrt{8}}$

2. Davisson and Germer experiment relates to
    a)   Interference   b) electron diffraction
    c)   polarisation   d) fluorescence

3. The potential outside a 3D Box is
    a) zero   b) infinity   c) one   d) always negative

4. The photoelectric effect involves only
    a) free electrons   b) bound electrons   c) free holes   d) holes and electrons

5. Lorentz-Fitzgerald contraction in the length of an object occurs
    a)   in a direction perpendicular to the direction of motion
    b)   in a direction parallel to the direction of motion
    c)   in all directions
    d)   in more than one direction

6. The twin paradox phenomenon is related to
    a) relativity of simultaneity   b) relativity of space
    c) relativity of time   d) none of the above

7. An electron, proton and a car all have same wavelength. The one possessing highest velocity is
    a) Electron   b) proton   c) car   d) all the above

8. For a given value of n, the number of electrons in an orbit is
    a) n   b) n^2 c) $2n^2$ d) 2n

...2

9. The zero point energy of a harmonic oscillator of frequency υ is

   a) $\dfrac{1}{2}h\upsilon$ b) $\dfrac{1}{3}h\upsilon$ c) $\dfrac{3}{4}h\upsilon$ d) $h\upsilon$

10. Two photons recede from each other, their relative velocity will be
    a) C   b) 2C   c) C/2   d) zero

11. The minimum uncertainty in the determination of the energy of an excited atom whose life time is 10^{-8} is
    a) 3×10^{-8}ev   b) 2×10^{-8}ev   c) 6.5×10^{-8}ev   d) 6.5×10^{-8}J

12. One kilogram of mass is completely converted in to heat energy. The heat produced in kilo calories will be
    a) 2.1×10^{10} b) $2.1 \times 10^{+13}$ c) 2.1×10^{16} d) 2.1×10^{20}

13. A clock keeps correct time on earth. It is put in a space ship travelling with velocity C/2. How many hours does it appear to lose in one day?
    a) $12\sqrt{3}$ b) $\left(24 - 12\sqrt{3}\right)$ c) 6   d) 8

14. Probability density current is dependant on ---------------- of the charges
    a) velocity   b) mass   c) momentum   d) energy

15. In a step potential there will be --------- barrier
    a) 1   b) 2   c) no   d) 3

II. Fill in the blanks :

16. The deBroglie wave length of an electron is 1.224 Å. The energy of electron ineV is _____
17. Tunnelling process explains --------------
18. An accelerated frame of reference must be _____
19. According to Newtonian Mechanicstime is a _____.
20. _____ is the operator for energy

III. True or False :

21. For a stationary state the probability density is independent of time.
22. Planck's constant is a dimensionless quantity.
23. Lorentz transformation reduces to Galilean transformation when v >> c
24. General Theory of relativity can be applied only to accelerated motion.

IV. Answer Briefly :

25. What is group velocity ?
26. What is photo electric effect ?
27. What is degeneracy?
28. What is anHermitian operator?
29. What is an inertial frame?
30. State the postulates of Special Theory of Relativity.

SECTION – B
ANSWER ANY FIVE QUESTIONS: **(5 x 5 = 25)**

31. The first order Bragg maximum of electron diffraction in a nickel crystal (d = 0.40886 A^o) occurred at a glancing angle of 65°. Calculate the de Broglie wavelength of the electrons and their velocities.

32. a. What is time dilation ?.
    b. How fast would a rocket have to go relative to an observer for its length to be contracted to 99% of its length at rest.

33. A particle is moving in one dimensional box and its wavefunction is given by
    ψ = A sin nΠx/a. If the wavefunction is normalized evaluate the value of A

34. Derive the eigenvaluefor energy operator.

35. Life time of a nucleus in the excited state is 10^{-12} s. Calculate the probable uncertainty inenergy and frequency of a photon emitted.

36. Explain the negative result of Michelson – Morley experiment.

37. Solve Schrödinger's equation for a particle in a 1-D box with impenetrable walls at x = 0 and x = a and obtain its energy eigen functions. Show that the energy levels of this system are discrete.

SECTION – C
ANSWERANYTHREE QUESTIONS: **(3 X 15 = 45)**

38. a. Describe with necessary theory Davisson and Germer experiment for establishing wave nature of the electron.
    b. Find the De- Broglie wavelength of an electron moving with velocity 10^7 m/s

39. Derive the Lorentz's transformation equations. Show that these equations reduce to the Galilean transformation equation when v $\ll$ c.

40. What is a potential well? Find its reflection and transmission co-efficient

41. Establish Schrodinger's time independent equation. Comment on 'probabilistic interpretation' and 'normalization' of the wave function.

42. What is proper length? Derive the expression for the contracted length **-5**.
    Derive the mass energy relation -10

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