Name : ..... B130330EC .....

National Institute of Technology Calicut

Test-2 Series Examination, March 2014

PHYSICS (PH1001)

Duration: 1 hour **Answer all the questions** **Max. Marks: 20**

Useful data: *$h=6.626\times10^{-34}$ Js , $e = 1.6\times10^{-19}$C, mass of proton $= 1.672\times10^{-27}$ kg, mass of deuteron $= 3.344\times10^{-27}$ kg*

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1. A free electron has a wave function $\psi(x) = A\sin(5\times10^{10}x)$ where x is in meters. Find the de Broglie wavelength and energy of the electron. **(2.5 Marks)**

2. The speed of a *20 keV* electron is measured with a relative error of *0.01%*. Determine the uncertainty in the measurement of its position? Neglect relativistic effects. **(2.5 Marks)**

3. A particle trapped in a one dimensional box of size L is in its n^{th} eigen state. What is the uncertainty in its momentum Δp? (**Hint** : for a particle trapped in a one dimensional box, $\Delta p = \sqrt{\langle p^2 \rangle}$) **(2.5 Marks)**

4. Write down the time-dependent and time-independent forms of the Schrodinger equation and explain the terms. What are the properties of well behaved wave functions? Give one example each for a well behaved wave function and a wave function that is invalid. **(1+2+1=4 Marks)**

5. A particle is described by the wave function

$$\psi(x) = 0 \quad ; -\infty \le x \le -3a$$
$$\psi(x) = c \quad ; -3a \le x \le a$$
$$\psi(x) = 0 \quad ; \quad a \le x \le \infty$$

where x is in centimeters. What is the probability of finding the particle within an interval of length *0.2a cm* anywhere between the points $x = 0$ and $x = a$? **(3 Marks)**

6. A proton and a deuteron (a particle with the same charge as proton but twice the mass) attempt to penetrate a rectangular potential barrier of height *10MeV* and thickness 10^{-14} *m*. If both particles have a total energy of *3MeV*, evaluate the probability of success for both particles. **(2.5 Marks)**

7. Draw the shape of the wave function for (i) a quantum harmonic oscillator in its ground state (ii) a quantum mechanical particle trapped in a one dimensional potential well of size L and infinite depth in its first excited state and (iii) a quantum mechanical particle trapped in a potential well of size L and finite depth in its first excited state. **(3 Marks)**

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