Question Paper

Exam Date & Time: 15-Nov-2018 (02:00 PM - 05:00 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

INTERNATIONAL CENTRE FOR APPLIED SCIENCES
FIRST SEMESTER B.SC. Applied Sciences in Engg.
END - SEMESTER THEORY EXAMINATIONS NOVEMBER - 2018 (For 2016 batch)
Physics - I [PH 111]

Marks: 100 **Duration: 180 mins.**

Answer 5 out of 8 questions.

Missing data, if any, may be suitably assumed.

Useful constants

Planck's constant h = 6.63 x 10^{-34} Js, Velocity of light c = 3x 10^{8} ms^{-1}.

Charge on electron = 1.6x10^{-19} C. Mass of electron = 9.1 x 10^{-31} kg.

Mass of proton = 1.67 x 10^{-27} kg.

1) What is interference of light? Explain the production of coherent waves. (6)

A)

B) What is a phasor? Obtain an expression for the intensity distribution in double slit interference using phasor method. (6)

C) A double-slit arrangement produces interference fringes for sodium light (wavelength = 600 nm) that are 0.25Â° apart. For what wavelength would the angular separation be 10% greater ? Assume, the angle θ is small. (4)

D) When the movable mirror is moved through a distance of 0.230 mm, 800 fringes swept across the field of view. What is the wavelength of the light used? (4)

2) Explain : i) Rayleigh's criteria of resolution of the images. b) X-ray diffraction by crystals. (6)

A)

B) Draw the schematic diagram of interference pattern due to relatively wide slits. Compare it with that of narrow slits pattern. (6)

C) A single slit is illuminated by light whose wavelengths are λ_a and λ_b, so chosen that the first diffraction minimum of λ_a component coincides with the second minimum of the λ_b component. i) What is the relationship between the two wavelengths? ii) Do any other minima in the two patterns coincide? (4)

D) A diffraction grating 3 cm wide produces a deviation of 33.2Â° in the second order with a light of wavelength 589 nm. Find the total number of rulings on the grating. (4)

3) Write the conditions for constructive and destructive interference of reflected light from a wedge shaped air film enclosed between two glass plates assuming normal incidence. Explain why an excessively thin film appears dark? (6)

A)

B) What is a grating? Deduce grating equation. (4)

C) In a Newton's rings experiment, the radius of curvature R of the lens is 5.0m and its diameter is 22 mm,wavelength of the light used = 600 nm. i) How many rings are produced? ii) How many rings would be seen if the arrangement is immersed in water(n = 1.3)? (6)

D) A grating has 6000 rulings/cm, how many orders of the entire visible spectrum (400-700nm) can be produced? (4)

4) Draw the graph of black body radiation curve. What is ultra-violet catastrophe? (6)

A)

B) What is Compton effect? What are classical predictions and experimental observations? (6)

C) Electrons are ejected from a metallic surface with speeds up to 4.60 x 10^5 m/s when a light of wavelength of 625 nm is used. (a) What is the work function of the surface? (b) What is the cut-off frequency for this surface? (4)

D) An electron and a bullet (m= 20gm) each have a velocity of 500m/s accurate to within 0.010%. Within what limits could we determine the positions of the objects along the direction of the velocity? (4)

5) What are matter waves? Explain the physical significance of a wave function? (6)

A)

B) Deduce wave function of a particle of mass m confined in a finite potential well. (6)

C) A particle of mass m is confined to a one dimensional box between x=0 and x=L. Find the expectation value of the position x of the particle in the ground state. Assume (4)

$$\psi_n(x) = \sqrt{\frac{2}{L}} sin\left(\frac{n\pi x}{L}\right)$$

D) A 0.500 kg baseball is confined between two rigid walls of a stadium that can be modelled as a box of length 100m. Calculate i) the minimum speed of the ball ii) If the ball now moves with a speed of 150m/s determine the quantum number of the state in which the baseball resides. (4)

6) Draw the wave functions and probability densities of a particle confined in finite and infinite potential wells for the first three energy states. (6)

A)

B) What is Radial probability density? Obtain an expression for the same in case electron of an hydrogen atom. (4)

C) i) Calculate the most probable value and average value of r for an electron in the ground (10)
state of the hydrogen atom. Given :

$$\psi_{1S}(r) = \frac{1}{\sqrt{\pi a_0^3}} \exp\left(-\frac{r}{a_0}\right)$$

ii) Also calculate the probability that the electron will be found outside the first Bohr radius.

7) Explain briefly the components of a laser. (6)

A)

B) Give construction and working of an optical fibre. (6)

C) A pulsed laser emits light at a wavelength of 650 nm. If the energy release per pulse is 150 mJ, how many photons are there in each pulse ? (4)

D) A quantum oscillator consists of an electron bound by a restoring force constant 9 N/m. What is the longest wavelength of light that can excite the oscillator? (4)

8) Draw a representative graph of Resistance Vs Temperature for a superconductor and a normal conductor and hence explain critical temperature. (4)

A)

B) Explain i) Meissner effect ii) Doping of semiconductors iii) Pumping in lasers (6)

C) Most solar radiation has awavelengthof0.750 μm or less. What energy gap should the material in solar cell have in order to absorb this radiation ? Is silicon (Eg= 1.14 eV) appropriate? (5)

D) Calculate the energy of a conduction electron in silver at 800 K, assuming the probability of finding an electron in that state is 0.950. The Fermi energy is 5.48 eV at this temperature. (5)

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