INTERNATIONAL CENTRE FOR APPLIED SCIENCES

(Manipal University)

I SEMESTER B.Sc. (Applied Sciences) EXAMINATION- NOV. 2017

SUBJECT: PHYSICS I (IPH 111)

Wednesday, 15 November 2017

Duration: 3 Hrs. **Max. Marks: 100**

Note: * Answer any ***five full questions*** each carry 20 marks
* Answer in specific and to the point. Missing data may be suitably assumed
* Draw neat sketches wherever necessary.

Physical Constants:

Speed of light in vacuum	$= 3.00 \times 10^{8}$ m/s	Electron charge	$= 1.60 \times 10^{-19}$ C
Mass of proton / neutron	$= 1.67 \times 10^{-27}$kg	Electron mass	$= 9.11 \times 10^{-31}$ kg
Boltzman constant	$= 1.38 \times 10^{-23}$ J/ K	Planck's constant	$= 6.63 \times 10^{-34}$ J-s

1A. What are coherent waves? Explain how they are produced.

1B. Explain the reason for formation of circular fringes in case of Newton's rings. With a neat diagram, arrive at an expression for the radius of the n^{th} bright and dark fringes.

1C. **a)** The double slit arrangement is illuminated by light of wavelength 546 nm. The slits are 0.12 mm apart and the screen on which interference pattern appears is 55 cm away. What is the angular position of (i) first minima and (ii) tenth maxima? What is the separation between two adjacent maxima?

b) Find the sum of the following quantities graphically (phasors method):

$y_1 = 10 \sin(\omega t)$, $y_2 = 8.0 \sin(\omega t + 30°)$ **(4+8+8=20 marks)**

2A **a)** What is a diffraction grating?

b) State Brewster's Law and, prove that $n = \tan \theta p$

2B Derive an expression for intensity of diffraction pattern in case of single-slit, using phasor diagram. Draw the relevant graph and explain.

2C **a)** Light of wavelength 590nm is used to view an object under a microscope. If the aperture of the objective has a diameter of 0.9cm, what is the limiting angle of resolution? If we were possible to use visible light of any wavelength, what would be the maximum limit of resolution for this microscope?

b) A certain grating has 10^4 slits with a spacing of d = 2100 nm. It is illuminated with yellow sodium light (λ = 589 nm). Find the angular position of all principal maxima observed **(4+8+8=20 marks)**

3A State Stefan's law and Wien's Displacement law and write the mathematical expressions.

3B Derive the Compton shift equation when a x-ray photon is scattered by an electron and draw the relevant graphs of intensity versus wave length when the angle of scattering is 0° and 90°.

3C **a)** Molybdenum has a work function of 4.2eV. (a) Find the cut off wavelength and cut off frequency for the photoelectric effect. (b) What is the stopping potential if the incident light has wavelength of 180 nm?

b) The speed of an electron is measured to be 8.00 x 10^3 m/s to an accuracy of 0.0030%. Find the minimum uncertainty in determining the position of this electron. **(4+8+8=20 marks)**

4A **a)** The wave function ψ contains necessary information that can be known about the particle. Justify this statement with any two illustrations.

4B Arrive at an expressions for the energy values and wave function of a quantum particle trapped in an infinite potential well and draw the relevant graphs.

4C **a)** A 40-eV electron is incident on a square barrier of height 60 eV. What is the probability that the electron will tunnel through the barrier if its width is (A) 2.0 nm? (B) 0.10 nm?

b) A 0.80 kg baseball is confined between two rigid walls of a stadium that can be modeled as a box of length 200 m. Calculate the minimum speed of the baseball. If the baseball is moving with a speed of 250 m/s, what is the quantum number of the state in which the baseball will be?

(4+8+8=20 marks)

5A Explain briefly the BCS theory of superconductivity in metals.

5B **(i)** Explain briefly the energy band theory of solids. **(ii)** What are extrinsic semiconductors?

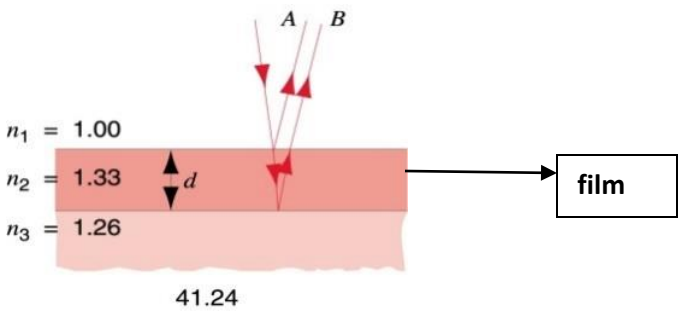
5C **a)** A three level laser emits light of wavelength 550 nm. **(i)** What is the ratio of population of the upper level (E2) to that of the lower level (E1) in laser transition, at 300 K? **(ii)** At what temperature the ratio of the population of E2 to that of E1 becomes half?

b) The energy gap for silicon at 300K is 1.14eV. (i) Find the lowest frequency photon that can promote an electron from the valence band to the conduction band. (ii) What is the wavelength of this photon? **(4+8+8=20 marks)**

6A Explain the mathematical representation of a wave packet and draw the relevant diagram.

6B With a neat diagram explain the construction of Michelson interferometer. Explain how it can be used to determine the wavelength of a monochromatic light.

6C **a)** If the wavelength of the incident light is λ = 572 nm, rays A and B in the following figure are out of phase by 1.50 λ. Find the thickness "d" of the film.



b) Calculate the ground state energy and the amplitude of vibration of an electron considered to be a harmonic oscillator having frequency 200Hz. **(4+8+8=20 marks)**

7A **a)** Explain double refraction.

7B What are the experimental observations on photo electric effect? How Einstein explained these observations. Draw the relevant graphs.

7C **a)**A slit of width "a" is illuminated by white light. For what value of "a" does the first minimum for red light of wave length λ = 655nm fall at an angle $\theta = 18^{o}$?

b) Calculate the momentum and energy of a photon of wave length 560nm.

(4+8+8=20 marks)

8A. Explain the terms **(i)** spontaneous emission and **(ii)** stimulated emission.

8B. Deduce the form of solution for a particle in a finite potential well. Sketch the wave functions for the lowest three energy states.

8C **a)** The wave function for H-atom in ground state is $\psi_{1s}(r) = \frac{1}{\sqrt{\pi a_0^3}} \exp\left(-\frac{r}{a_0}\right)$.

Obtain an expression for the radial probability density of H-atom in ground state.

Sketch the probability curve.

b) An electron is confined in an infinite potential well of width 0.28nm. Calculate the energy values for the states n =1, 2 and 3. **(4+8+8=20 marks)**