Reg. No.									

प्रज्ञानं ब्रह्म

Manipal

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INTERNATIONAL CENTRE FOR APPLIED SCIENCES

(Manipal University)

I SEMESTER B.S. DEGREE EXAMINATION – JUNE 2016

SUBJECT: PHYSICS - I (PH 111)

(COMMON TO ALL BRANCHES)

(OLD SCHEME)

THURSDAY, 9th JUNE, 2016

Time: 3 Hours **Max. Marks: 100**

- ✓ **Answer ANY FIVE FULL Questions.**
- ✓ **Write the question number clearly on the left side of the margin.**
- ✓ **Any missing data may be suitably assumed**

Physical Constants:

Elementary charge: 1.6×10^{-19} C

Mass of electron: 9.1×10^{-31} kg

Boltzmann constant: 1.38×10^{-23} J/K

Planck's constant: 6.625×10^{-34} J.s

Stefan-Boltzmann constant: 5.67×10^{-8} W/m^{2}K^4

Speed of light in vacuum: 3.0×10^{8} m/s

1A.i) Explain the following terms (a) uniform circular motion; (b) simple harmonic motion.

ii) Show graphically the force and the corresponding potential energy of a simple harmonic oscillator.

1B. What is a torsional oscillator? Derive an expression for the time period of a torsional pendulum.

1C. i) An oscillator consists of a block of mass 512 g connected to a spring. When set into oscillation with amplitude 34.7 cm, it is observed to repeat its motion every 0.484 s. Find (a) the frequency, (b) the angular frequency, (c) the force constant, (d) the maximum speed, and (e) the maximum force exerted on the block.

ii) A 95.2-kg solid sphere with a 14.8-cm radius is suspended by a vertical wire attached to the ceiling of a room. A torque of 0.192 N.m. is required to twist the sphere through an angle of 0.850 rad. Find the period of oscillation when the sphere is released from this position.

((2+2)+8+(5+3)=20 marks)

2A. i) Explain the principle of superposition of waves.

ii) How do transverse waves differ from longitudinal waves?

2B. Derive an expression for velocity of transverse waves in a stretched string from Newton's second law. Mention any two characteristics of standing waves.

2C i) A string 2.72 m long has a mass of 0.263 kg. The tension in the string is 36.1 N. What must be the frequency of traveling waves of amplitude 7.70 mm in order that the average transmitted power be 85.5W?

ii) The equation of a transverse wave traveling along a string is given by,

$$y = (2.3mm)\sin[(1822rad/m)x - (588rad/s)t].$$

Find (a) the amplitude, (b) the velocity, (c) the wavelength of the wave, and (d) the maximum transverse speed of a particle in the string.

((2+2)+8+(4+4) = 20 marks)

3A. i) Mention the conditions for interference of light waves and any two conditions for good contrast of the interference pattern.

ii) Write the equations for thin-film interference (in air).

3B. i) Obtain an expression for the radius of m^{th} order bright ring in the case of Newton's rings.

ii) Draw the diagram of the Michelson's interferometer and label its parts. Explain how microscopic length measurements are made in this.

3C. i) In a double-slit experiment the distance between slits is 4.80 mm and the slits are 1.86 m from the screen. Two interference patterns can be seen on the screen, one due to light with wavelength 486 nm and the other due to light with wavelength 656 nm. Find the angular separation and the separation on the screen between the third-order interference fringes of the two different patterns.

ii) In an interference experiment in a large ripple tank the coherent vibrating sources are placed 120 mm apart. The distance between maxima 2.0 m away is 180 mm. If the speed of ripples is 0.25 m/s, calculate the frequency of the vibrating sources.

((2+2)+(4+4)+(4+4) = 20 marks)

4A. i) With relevant diagram, explain polarization by refraction in a stack of glass plates.

(ii) When a liquid is introduced into the air space between the lens and the plate in a Newton's rings apparatus, the diameter of the tenth dark ring changes from1.50 to 1.31 cm. Find the index of refraction of the liquid.

4B. Obtain an expression for the intensity in single-slit diffraction pattern, using phasor-diagram. Sketch the diffraction pattern due to a single slit.

4C. i) In a double-slit experiment, the distance of the screen from the slits is 52 cm, the wavelength is 480 nm, slit separation is 0.12 mm and the slit width is 0.025 mm. (a) What is the spacing between adjacent fringes? (b) What is the distance from the central maximum to the first minimum of the fringe envelope? (c) How many bright fringes are there in the central peak of the diffraction envelope?

(ii) A sheet of glass having an index of refraction of 1.40 is to be coated with a film of material having an index of refraction 1.55 such that green light (λ=500 nm) is preferentially transmitted. What is the minimum thickness of the film that will achieve the result? Which wavelength (>700 nm) is minimally transmitted by this glass, in the infrared region?

((2+2)+8+(4+4) = 20 marks)

5A. i) Distinguish between Fresnel and Fraunhofer Diffraction.

ii) Give at least two reasons why the usefulness of large telescopes enhances as we increase the lens diameter.

5B. With relevant diagrams, explain circular polarization of light by double refraction and optical activity.

5C. i) Add the following quantities algebraically, using the phasor method: E_1=10 sin ωt, E_2= 15 sin (ωt +35°), E_3= 5.0 sin(ωt-50°).

(ii) The two headlight of an approaching automobile are 1.20 m apart. At what i) angular separation and ii) maximum distance will the eye resolve them? Assume a pupil diameter of 5 mm and a wavelength of 550 nm, also assume that diffraction effects alone limit the resolution.

((2+2)+8+(5+3)=20 marks)

6A. i) Explain briefly the diffraction at a circular aperture.

ii) State and explain Bragg's law.

6B. Obtain an expression for the width of the central maximum in diffraction pattern due to multiple slits. Obtain an expression for dispersion by a diffraction grating.

6C. i) A diffraction grating has 250 ruling/mm, and a principal maximum is noted at 23°. What are the possible wavelengths of the incident visible light (range is 400-700 nm)?

ii)A beam of X-rays of wavelength 29.3 pm is incident on a calcite crystal of lattice spacing 0.313 nm. Find the smallest angle between the crystal planes and the beam that will result in constructive reflection of the X-rays.

((2+2)+8+(5+3) = 20 marks)

7A. i) Explain Planck's radiation law.

ii) Show that the group speed of a wave packet is equal to the particle speed.

7B. Explain Compton effect. Derive the Compton shift equation.

7C. i) Incident photons strike a lithium surface having a work function of 2.30eV, causing photoelectric emission. When a stopping potential of 3.92 V is imposed, there is no photocurrent. Find the wavelength of the incident photons.

ii) Consider a black body of surface area 10.0 cm^2 and temperature 5500 K. How much power does it radiate? At what wavelength does it radiate most intensely?

((2+2)+8+(4+4) = 20 marks)

8A. Give a brief account of tunneling of a particle through a potential energy barrier.

8B. By solving the Schrodinger equation, obtain the wave-functions for a particle of mass m in a one-dimensional "box" (infinite square well) of length L. Sketch the lowest two wave-functions and probability densities for the particle in a one-dimensional "box".

8C. i) An electron with kinetic energy 5.0 eV is incident on a barrier with thickness 0.20 nm and height 10.0 eV. What is the probability that the electron (a) will tunnel through the barrier? (b) will be reflected?

ii) A quantum simple harmonic oscillator consists of an electron bound by a restoring force proportional to its position relative to certain equilibrium point. The proportionality constant is 8.99 N/m. What is the longest wavelength of light that can excite the oscillator ?

(4+8+(5+3) = 20 marks)