U.G. 2nd Semester Examination - 2022

PHYSICS

[HONOURS]

Generic Elective Course (GE)

Course Code : PHY-H-GE-T-02A&B

Full Marks : 40 Time : $2\frac{1}{2}$ Hours

The figures in the right-hand margin indicate marks.

Candidates are required to give their answers in their own words as far as practicable.

Answer all the questions from selected option.

OPTION–A

PHY-H-GE-T-02A

(Waves & Optics)

GROUP–A

1. Answer any **five** questions: 2×5=10

a) State and explain the principle of superposition.

b) What are Lissajous figures?

c) Determine the amplitude, wave velocity, wave length and initial phase angle for the wave.

d) What do you mean by the absorption coefficient of a surface? What is the value of absorption coefficient of an open window?

e) State and explain Huygens principle.

f) Determine the thickness of a half wave plate and quarter wave plate for light wave of $\lambda = 6000Å$; given $\mu_0 = 1.535$ and $\mu_e = 1.555$.

g) What is a zone plate? Write down the expression of its focal length.

h) Express the velocity of light (c) in free space in terms of μ_0 and ε_0; also find the value of c substituting the values of μ_0 and ε_0 in the said expression.

GROUP–B

2. Answer any **two** questions: 5×2=10

a) What are the beats? Show that the number of beats per second produced by the source of two different frequencies is the difference in frequency of the two sources. 2+3=5

b) Explain the nature of Lissajous figure obtained due to superposition of the waves and positions of a particle executing SHM in three successive seconds are *x*, *y* and *z* respectively. Show that the time period of the motion can be expressed as. 2+3=5

c) What do you mean by *phase velocity* (v_p) and *group velocity* (v_g)? Show that the symbol λ has its usual meaning. 2+3=5

d) State and prove Brewster's law. For clear ice of r.i. 1.732 when used as a polarizer, determine the angle of polarization. 3+2=5

GROUP–C

3. Answer any **two** questions: 10×2=20

a) Derive the expression for the fringe width of the interference pattern formed in Young's Double Slit experiment. In a Young's Double Slit experiment, the distance between two slits is 1.0 mm and the perpendicular distance of the screen from the slits is 1.0 m ; If the fringe width is 0.6 mm, determine the wave length of monochromatic light used. Explain briefly how the wave length of a monochromatic light can be determined using Michelson's Interferometer. 4+2+4=10

b) Considering necessary assumptions derive Poiseuille's formula of liquid flow through a capillary tube. Define angle of contact. What do you mean by synclastic and anticlastic surface? 7+1+2=10

c) A displacement curve is given by for $0 < t < T$ and where A is a constant. Draw the graph of *f (t)* and obtain the Fourier series expansion for *f (t)*. Define bel and decibel. 6+4=10

d) What do you mean by reverberation and optimum reverberation? Considering necessary assumptions derive Sabine's formula of optimum reverberation.What is the difference between Fresnel and Fraunhofer diffraction? 2+6+2=10

OPTION–B

PHY-H-GE-T-02B

(Thermal Physics and Statistical Mechanics)

GROUP–A

1. Answer any **five** questions: 2×5=10

   a) State Stefan's law of black body radiation. What is the value of Stefan's constant in SI unit.

   b) What parameter of an ideal gas determines its internal energy and why?

   c) What is mean free path of a gas molecule? How does it depend on the density of molecules?

   d) What are bosons? Name two of them.

   e) Suppose, during adiabatic expansion, the volume of a gas is doubled whereas its absolute temperature is decreased by a factor of 1.32. Compute the number of degrees of freedom for the gas molecules.

   f) Define compressibility and Expansion Co-efficient.

   g) What do you mean by the thermal efficiency of a heat engine? Can this efficiency be 100%?

   h) State and explain Maxwell's law of distribution of molecular velocities. Show graphically the same for at least two temperatures.

   i) Show that the Rayleigh-Jeans law is a particular case of Planck's law of black body radiation.

   j) What is Fermi temperature. What does it signify?

GROUP–B

2. Answer any **two** questions: 5×2=10

   a) Write down the Plank's quantum postulates. What is the wave length of the maximum intensity of the radiation radiated from a source at temperature 3000^{o}C? 2+3

   b) 1 kg of water is boiled under pressure of 2 atm at $120^{o}C$. If the volumes occupied by the water and steam under given conditions are $10^{-3}\,m^{-3}$ and $0.824 m^{-3}$, respectively, find the increase in the internal energy. Given: $L = 2.2\times10^{6}\,J/kg$, $1\ atm = 1.013\times10^{5}\,Nm^{-2}$. 5

   c) State the third law of thermodynamics. How can one infer from this law that the temperature absolute zero can never be reached? 2+3

d) Why is the TS diagram a better option than the PV diagram in dealing with a Carnot cycle? Can an irreversible process be plotted on TS diagram and why? 3+2

GROUP–C

Answer any **two** questions: 10×2=20

3. a) Suppose two spheres having radii 1 m and 4 m, are made of the same material. If they are kept at temperatures 4000 K and 2000 K, respectively, find the ratio of the radiated energies per second.

b) How does one realise a perfect black body in reality? Derive an expression for the pressure of radiation inside the black body chamber. 5+(2+3)

4. a) Write down the Bose-Einstein distribution law explaining each term. Show that for a photon gas, the density of states is proportional to E^2, where E corresponds to energy.

b) What is the total number of free electrons per unit volume at room temperature for a metal having Fermi energy 7 eV. (1+4)+5

5. a) Show that for one mole of van der Waal's gas

$$dQ = C_V dT + \frac{RT}{(V-b)} dV$$

b) From *TdS* equations show that

$$C_P - C_V = T\left(\frac{\partial V}{\partial T}\right)_P \left(\frac{\partial P}{\partial T}\right)_V .$$ 5+5

6. a) Prove that no two adiabatic lines can intersect.

b) Show and explain schematically the four stages of operation of a Carnot's cycle.

c) We know that in *Joule-Thomson* expansion experiment enthalpies are equal for initial and final states. Does that imply that enthalpy remains constant throughout the process? – Explain. 2+(2+4)+2

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