# 2008

## PHYSICS

*Full Marks* : 40

*Time* : 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*

*Illustrate the answers wherever necessary*

PAPER—PH 2102 A

[ *Marks* : 20 ]

( *Spectroscopy and Laser Physics* )

Answer **Q. No. 1** and any *one* from the rest

1. Answer any *four* bits :  $2\frac{1}{2} \times 4$

   ( *a* ) The force constant of HCl molecule is $4 \cdot 8 \times 10^5$ dyne/cm. Find the energy required to increase the nuclear separation by 1 Å.

( *Turn Over* )

(b) The moment of inertia of CO molecule is $1.46 \times 10^{-46}\,\mathrm{kg\,m^2}$. Calculate the angular velocity in the lowest rotational energy level of CO molecule.

(c) Name the different regions of the electromagnetic spectrum (Frequency range $3 \times 10^6$ to $3 \times 10^{20}\,\mathrm{Hz}$) with approximate frequency range.

(d) The rotational constant of $H^{35}Cl$ is observed to be $10.5909\,\mathrm{cm^{-1}}$. What are the values of $B$ for $H^{37}Cl$?

$h = 6.626 \times 10^{-34}\,\mathrm{JS}$; $K = 1.381 \times 10^{-23}\,\mathrm{JK^{-1}}$

$C = 2.998 \times 10^8\,\mathrm{ms^{-1}}$; $^1H = 1.673 \times 10^{-27}\,\mathrm{kg}$

$^{35}Cl = 58.06 \times 10^{-27}\,\mathrm{kg}$;

$^{37}Cl = 61.38 \times 10^{-27}\,\mathrm{kg}$

(e) What is $Q$-switching in laser? Write the possible duration of laser pulse in electro-optic, opto-mechanical and passive $Q$-switching.

(Continued)

(f) Using 'Burger's law' show that the amplification of light is not possible in a two level laser system.

2. Describe in details the essential spectroscopic features assuming diatomic molecules as a non rigid rotator and anharmonic oscillator. What is meant by vibrational coarse structure ? $7 + 3$

3. What is a three level laser system ? Discuss the energy level diagram of a three level laser system with an example. Obtain the equation of population inversion of the three level laser system. Show that population inversion can be achieved in such laser system by applying pumping power. $1 + 2 + 5 + 2$

PAPER—PH 2102 B

[*Marks* : 20 ]

( *Photonics* )

Answer **Q. No. 1** and any *one* from the rest

1. Answer any *four* bits :

   $2\frac{1}{2} \times 4$

   (a) Describe the working principal of an optical fibre and explain the necessity of cladding in it.

   (b) Write a short note on "basic holography equation".

   (c) Write the advantages of an optical logic system over the electronic logic system.

   (d) Construct an opto electronic "full adder" circuit.

   (e) Design opto electronic AND, NOT and NOR gate.

   (f) Prove that the refractive index of a centro symmetric non-linear crystal becomes intensity dependent.

2. (a) What do you mean by non-linearity of a medium ?

   (b) How this non-linearity can be used for achieving second harmonic generation ? Discuss it with supporting figure.

(*Continued*)

**( 5 )**

(c) Discuss also the process of self focussing by exploitation of non-linear phenomenon of a dielectric medium.  $2 + 5 + 3$

3. (a) Why a coherent light is used for holographic recording?

(b) What is the advantage of holographic recording over photographic recording?

(c) What is meant by acceptance angle and numerical aperture of an optical fibre?

(d) What do you mean by a graded-index fibre? Discuss its advantages over a step index fibre.

(e) A step index fibre has a core of refractive index 1·50 and a cladding of refractive index 1·40. Calculate the numerical aperture and the acceptance angle in water environment (r.i of water is 1·33)?

(f) What is V-parameter of an optical fibre and what is its physical significance?

$1 + 1 + 2 + 2 + 2 + 2$