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3 TDC (Special) PHY M 1

2016

(July)

PHYSICS

(Major)

Paper : 30100

**(Atomic and Molecular Physics and
Theory of Relativity)**

Full Marks : 67

Time : Three hours

**The figures in the margin indicate
full marks for the questions.**

1. Choose the correct answer : $1 \times 7 = 7$

(a) The velocity of the electron in 1st Bohr orbit is

(i) $\frac{1}{10}c$

(ii) $\frac{1}{13.7}c$

(iii) $\frac{1}{137}c$

(iv) $\frac{1}{1370}c$

Contd.

(b) The principal series of H-atom is observed during the transition of the electron from

- (i) s- to p-states
- (ii) p- to s-states
- (iii) d- to p-states
- (iv) p- to d-states

(c) Which of the following has the highest frequency ?

- (i) Visible light
- (ii) UV light
- (iii) X-rays
- (iv) IR-rays

(d) The yellow D-lines of sodium spectrum correspond to

- (i) sharp series
- (ii) fundamental series
- (iii) principal series
- (iv) diffuse series

(e) The selection rule for azimuthal quantum number is

- (i) $\Delta n_\phi = \pm 1$
- (ii) $\Delta n_\phi = 0 ; \pm 1$
- (iii) $\Delta n_\phi = 0$
- (iv) None of the above

(f) The Stokes and anti-Stokes lines of Raman spectra are

- (i) equally spaced
- (ii) irregularly spaced
- (iii) continuous
- (iv) None of the above

(g) The energy levels of a multielectron atom depend on

- (i) n
- (ii) l
- (iii) both n and l
- (iv) None of the above

2. Answer **any five** of the following : $2 \times 5 = 10$

- Calculate the wavelength of Balmer series limit. ($R = 1.097 \times 10^7 \text{ m}^{-1}$)
 - State and explain the basic postulates of special theory of relativity.
 - Explain what do you mean by LASER and MASER.
 - Write down the spectral notation for the ground state of H-atom.
 - What is the meaning of mass-energy equivalence? Explain with example.
 - Distinguish between normal and anomalous Zeeman effect.
3. (a) State and prove Bohr's correspondence principle. Establish the truthfulness of the statement, "the greater the quantum number, closer the quantum physics approaches classical physics". $1+3+1=5$
- (b) Give a brief account of the Sommerfeld relativistic correction to explain the fine structure of hydrogen.

Or

Illustrate LS and JJ coupling with the help of vector diagram. Give the selection rules for L, S and J. $4+3=7$

4. (a) Distinguish between continuous and characteristic X-ray spectra. Why is the characteristic spectra so called? $3+1=4$
- (b) State Moseley's law. What is its importance? 4
5. (a) Obtain an expression for the rotational energy levels of a diatomic molecule, taking it as a rigid rotator. Discuss its spectrum and the relevant selection rules. 6
- (b) How is Raman effect explained on the basis of quantum theory? Explain the origin of Stokes and anti-Stokes lines in Raman spectrum. Why are the anti-Stokes lines fainter than Stokes lines? $2+2+2+1=7$
- (c) Discuss, with suitable diagrams, the principle, construction and working of a He-Ne laser. 6

6. (a) Derive the Lorentz space-time transformation formulae.

(b) A rod of 1 metre long is moving along its length with a velocity $0.6c$ along x -axis. Calculate the percentage change in its length as observed by a stationary observer. What will be its new length if the observer is moving along $-ve$ x -axis with a constant velocity $0.1c$?

Or

Write short notes on : (any two)

(i) Properties of LASER

(ii) Relativity of simultaneity

(iii) Application of Raman effect.