2016

PHYSICS

(Major)

Paper : 5.2

(Atomic Physics)

Full Marks : 60

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Choose the correct option : 1×7=7

(a) The ratio of e/m of a proton to e/m of an electron is

(i) 1837

(ii) $\frac{1}{1837}$

(iii) $\frac{1}{1000}$

(iv) None of the above

(b) No two electrons in an atom will have the four quantum numbers identical. This statement is known as

(i) Heisenberg's uncertainty relation

(ii) Selection rule

(iii) Pauli's exclusion principle

(iv) None of the above

(c) The energy levels of a multi-electron atom depend on

(i) n

(ii) l

(iii) both n and l

(iv) None of the above

(d) The formation of electronic spectrum is due to

(i) change in electronic energy

(ii) change in vibrational energy

(iii) change in rotational energy

(iv) All of the above

(e) If a photon has a wavelength equal to the Compton wavelength, the energy of the photon is

(i) $E = \frac{1}{2} m_0 c^2$

(ii) $E = m_0 c^2$

(iii) $E = \frac{h}{m_0 c}$

(iv) None of the above

(f) The rotational energy level of a molecule is

(i) equally spaced

(ii) unequally spaced

(iii) Both of the above

(g) Matter waves

(i) are longitudinal

(ii) are electromagnetic

(iii) always travel with speed of light

(iv) show diffraction

2. Answer any *four* of the following : 2×4=8

(a) Calculate the time taken by the electron to traverse the first Bohr orbit in

hydrogen atom. Given,

Electronic charge

$e = 1 \cdot 6 \times 10^{-19}$ coulomb

Radius of the first orbit

$r_1 = 0 \cdot 526 \times 10^{-10}$ m

Velocity of electron in first orbit

$= 2 \cdot 19 \times 10^{6}$ m / sec

(b) Show that in a state of principal quantum number n, the maximum number of electron is $2n^2$.

(c) What is Lande g-factor? Use it to express the anomalous magnetic splitting of D lines of sodium.

(d) Show that it is not possible for a photon to transfer its entire energy to the recoil electron in Compton effect.

(e) What is the physical quantity expressed by the unit of electronvolt? Give the relation between electronvolt and joule.

(f) What is space quantization? Explain briefly.

3. Answer *(a)* and any *two* from *(b)*, *(c)* and *(d)* : 5×3=15

(a) Differentiate between Zeeman effect and Paschen-Back effect.

(b) Describe the improvement made by Sommerfeld in Bohr's atomic model. How could it explain the fine structure of hydrogen spectral lines?

(c) With the exciting line of 2536 Å, the Stokes-Raman line for a sample is observed at 2612 Å. Calculate the wavelength of antiStokes-Raman line.

(d) Write a short note on any *one* of the following :

(i) excitation and ionization potential

(ii) Moseley law

(iii) L-S and J-J coupling schemes

4. Answer *(a)* and *(b)* and any *one* from *(c)*, *(d)* and *(e)* : 10×3=30

(a) Draw a neat and labelled diagram of the apparatus used by Thomson for

determination of q / M of positive rays. Show mathematically that positive ions with the same q / M value trace out a parabola. Explain how the mass of an isotope can be determined from the parabolic traces. 2+6+2=10

(b) Explain the emission of characteristic X-ray. Draw an energy-level diagram for K_α, K_β, L_α, L_β lines of characteristic X-ray spectrum. How does the frequency of characteristic X-ray depend upon the atomic number of element? 3+4+3=10

(c) What are the characteristics of the Raman effect? Discuss the theoretical explanation of Raman effect. Write the experimental method to obtain Raman spectrum. 3+5+2=10

(d) What is normal Zeeman effect? Give the theory of normal Zeeman effect and show how you can determine the value of specific charge (e / m) of electron with its help. 2+5+3=10

(e) What is Rayleigh scattering? Why do fog lamps in cars use yellow-colour light? Mention two differences between Rayleigh scattering and Compton scattering. A photon of energy $h\nu$ undergoes Compton scattering due to an electron by an angle θ. Show that the energy of the scattered photon is

$$\frac{h\nu}{1+\frac{h\nu}{m_0c^2}(1-\cos\theta)}$$

where m_0 is the rest mass of the electron and c is the speed of light in vacuum. 1+2+2+5=10

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