# 2019

## Part – II

## PHYSICS

## (Honours)

## Paper – IV

(New syllabus)

*Full Marks – 90*

*Time : 4 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.*

## GROUP – A

Answer any **two** questions : 15×2

1. (a) Define gyromagnetic ratio and find the relation between $\vec{\mu}_s$ and $\vec{S}$ in terms of gyro magnetic ratio. 1+2

(b) Apply the space quantization principle to determine the values of J for the following values of L and S vectors, L=2, S=$\frac{3}{2}$. Also find the spectroscopic notations and specify the ground state. 1+2+1

(c) The ground state of chlorine is $^2P_{3/2}$ find its magnetic moment. How many substrate will the ground state split in a weak magnetic field. 2+2

(d) 'Infrared and Raman measurements complement each other'– Justify. 2

(e) 'Explain the advantages of using laser as a Raman source. 2

2. (a) What do you mean by 'generalised co-ordinates' ? What do they signify ? What is the advantage of using them ? 1+1+2

(b) Can you define lagrangian uniquely ? Show by direct substitution $L'(q, \dot{q}, t) = L(q, \dot{q}, t) + \frac{dF(q,t)}{dt}$ also satisfies lagrange's equations, where f(q,t) is any differentiable Functions of generalined co-ordinate and time. 1+3

(c) Set up the Hamilton's equations of motion for the following lagrangian $L = L(q, \dot{q}, t) = \frac{1}{2}m$ $(\dot{q}^2 \sin^2 wt + q\dot{q}w \sin^2 \omega t + q^2w^2)$ 2+2

(d) Define cyclic cordinates. Show that the generatised momenta corresponding to cyclic co-ordinates are conserred. 1+2

3. (a) State the semi emperical mass formula for nuclear binding energy. 3

(b) What is Mass parabola ? How does mass parabola explain the stability of nuclei of some isobar. 1+2

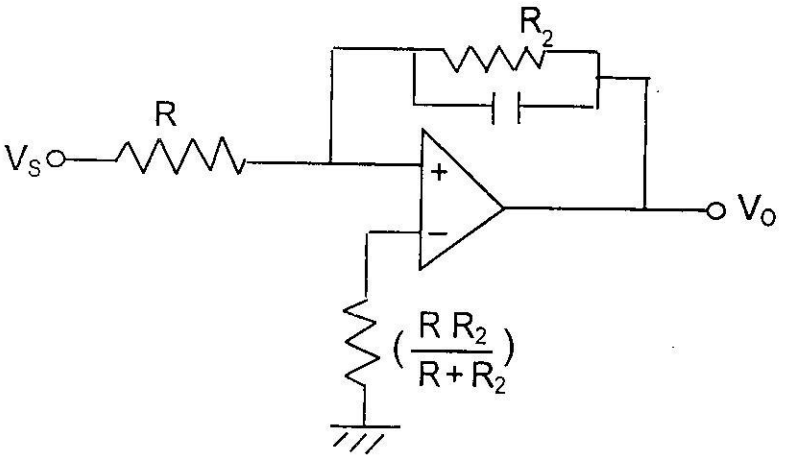
(c) What do you mean by find structure of $\alpha$ particle ? 2

(d) What is Range of $\alpha$-particle ? What is stragling of range. 1+1

(e) A particular type of nucleus with decay cinstant is being produced artificially using accelerator at a steady rate of P nuclei per second show that the number of nuclei present t sec after the production starts is $N(t) = \frac{p}{\lambda}$ $(1 - e^{-\lambda t})$. 5

4. (a) Describe the use of an OPAMP as an inverting amplifier. What is 1/3 voltage gain ? What is the phase difference between the input and output voltages ? Why is the inverting terminal a virtual earth ? 3+1+1+2

(b) Show that for the given circuit, the frequency at which the voltage gain falls to $\frac{1}{\sqrt{2}}$ of its low frequency value is given by $\frac{1}{2\Pi CR_2}$ 4




(c) Design a 4bit shift register using D Flip-flops and explain its operation. 2+2

## GROUP – B

Answer any **five** questions : 8×5

5. (a) What is population inversion in LASER ? How is the populationin version achived in He-Ne Laser. 2+3

(b) Calculate the ratio of stimulated to spontaneous emission rates for the wavelength $\lambda$ =6000A° at 250°C. 3

6. (a) State and expalin Moseley's Law. What is its importance ? 2+2

(b) The K-absorption edge in tungsten is $\lambda_{\alpha}$ =0.178A° and the wavelengths of some

lines in K series are $\lambda_\alpha$ =0.210A and $\lambda_\beta$ =0.184A. If a tungsten target is bombarded with electons of 120 KeV, Find the value of the maximum kinetic energies of electrons emitted from n=1, 2 levels. 4

7. (a) Convert $(1A7.2F)_{16}$ to decimal. 2

(d) Show that $(A \oplus B) \oplus C = A \oplus (B \oplus C)$ symbols have their usual meaning. 3

(c) Design a two input XOR gate exclusively with the help of NAND gates. 3

8. (a) Draw the circuit diagram of a phase shift oscillator, explain its operation, and find its frequency of oscillation. What is the minimum gain required for sustained osillation ? 1+2+2+2

(b) Why are RC oscillators commonly used in labaratories. 1

9. (a) Establish the equation of continuity of an ideal fluid of density P. What is its physical content ? Find the forms (a) in streamline motion and (b) for incompressible fluicls. 3+1+1+1

(b) Find the number of degrees of freedom in case two point masses connected by a *massless* spring. 2

10. (a) The potential energy of a partical is given by

$$V(x) = x^4 - 8x^3 - 6x^2 + 24x$$

Find the points of stable and unstable equilibrium.

(b) Find the normal co-ordinates of the system having the Lagragian L given by 4

$$L = \frac{1}{2}\left(\dot{x}^2 + \dot{y}^2\right) - \frac{1}{2}\left(W_1^2 x_1^2 + W_2^2 x_2^2\right) + \alpha xy$$

11. (a) What are the process through which $\alpha$-ray interact with matter ? 3

(b) Explain qualitatively that emission of-K shell electron is more probable during pholtoelectric emission by $\alpha$-ray. 3

(c) Calculate the minimum energy required for pair production. 2

12. (a) What is alkali spectra ? Explain the origin of Na - $D_1$ and $D_2$ line. 1+3

(b) What is Auger effect ? 2

(c) Calculate Lande g-factor for the state $3p_1$. 2

## 2GROUP – C

Answer any **five** questions : 4×5

13. Show that the transformations

$$Q = \ln\left[1+\sqrt{q}\,\text{Cos}p\right] \text{ and}$$

$$P = 2\sqrt{Q}\,\text{Sin}(p)\left[1+\sqrt{q}\,\text{Cos}p\right]$$

are canonical. 4

14. State with reasons the nature of constraints in the following cases.
    (a) A disc rolling down an incline plane without slipping.
    (b) A molecule inside a gas container. 2×2

15. In a stern-Gerlach experiment, the gradient of magnetic field is 5 volts $m^{-2}$/mm with a pole pieces 0.07m long. A narrow beam of silver atoms from an oven at 1250k passes throngh the magnetic field. Calculate the separation of the beams as they emerge from the magnetic field. 4

16. A beam of electrons enters a uniform magnetic field of fluxdensity 1.2wb/$m^2$. Find the energy difference between electrons whose spins are *parallel and antiparallel.* 4

17. (a) "LC oscillators are not suitable for generating AF signals". Justify the statement. 2

(b) Why are RC oscillators commonly used in Laboratories. 2

18. Find the relation between the open loop and closed loop gain of a negative amplifier. Hence show that negative feed back can improve the stability of gain of amplifier. 2+2

19. (a) An equality detector given an output if A and B are 1 both or o both Implement the circuit. 2

(b) Draw a single bit comparator circuit using basis gates. 2

20. $^{7}Li(Z=3)$ and $^{7}Be(Z=4)$ have the atomic masses 7.016005u and 7.016929u respectively. Which of them shown $\beta$-activity and of what type ? Calculate Q for it. 4