12521

Reg. No. | | | | | | | | | |

V Semester B.Sc. Degree Examination, March/April - 2023

PHYSICS

Quantum Mechanics, Solid State Physics and Electronics

(CBCS Semester Scheme Freshers 2020-21 Onwards)

Paper : V

Time : 3 Hours **Maximum Marks : 70**

Instructions to Candidates:

1. **All Multiple-Choice questions in PART A are to be compulsorily answered in page 1.**
2. **Use of Non - Programmable scientific calculator is allowed.**

PART - A

Answer ALL questions. Each question carries 1 marks. **(10×1=10)**

1. Assuming the velocity to be the same, which particle is having longest de Broglie wavelength.

   a) An electron b) A proton

   c) A neutron d) An alpha particle

2. If the uncertainty in the measurement of position of an electron is zero, the uncertainty in the measurement of its momentum is

   a) $< \hbar/2$ b) $< \hbar/2$

   c) Zero d) Infinity

3. The energy operator in one dimension is

   a) $i\hbar\frac{\partial}{\partial t}$ b) $\frac{i}{\hbar}\frac{\partial}{\partial t}$

   c) $-i\hbar\frac{\partial}{\partial x}$ d) $-i\hbar^2\frac{\partial}{\partial x}$

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4. Which of the following is correct?

   a) Metals possess low electrical and thermal conductivities

   b) For metals, resistivity is inversely proportional to temperature

   c) Metals obey Ohm's law at moderate temperature

   d) For a metal, the ratio of electrical to thermal conductivity is directly proportional to absolute temperature

5. The crystalline structure of NaCl is

   a) Simple Cubic b) Face-centred cubic

   c) Hexagonal close packing d) Body-centred cubic

6. As the applied voltage increases, the minimum wavelength of X-rays emitted

   a) Increases

   b) Decreases

   c) Remains same

   d) Increases or decreases depending on the metal

7. Elements having energy gap in the range of 1 eV behave as

   a) Conductors b) Insulators

   c) Semiconductors d) Superconductors

8. For a transistor $\beta = 100$. The value of α is

   a) 1.01 b) 0.99

   c) 0.01 d) 0.09

9. Which of the following is not correct for an ideal operational amplifier?

   a) The input current is zero

   b) The output resistance is infinite

   c) The input resistance is infinite

   d) Voltage gain is infinite

10. Which of these sets of logic gates are known as universal gates?

a) XOR, NAND, OR

b) OR, NOT, XOR

c) NOR, NAND, XNOR

d) NOR, NAND

PART - B

Answer any FIVE questions. Each question carries 2 marks. **(5×2=10)**

11. What are matter waves? Write the expression for de Broglie wavelength.

12. What is a wavefunction? Explain.

13. Write the expression for energy of a linear harmonic oscillator. What is zeropoint energy?

14. Mention any two merits of classical free electron theory of metals.

15. State Bloch theorem.

16. State Moseley's law. Mention any one of its importance.

17. What is an operational amplifier?

18. Write BCD code for the decimal number 72.

PART - C

Answer any FIVE questions. Each question carries 6 marks. **(5×6=30)**

19. Explain briefly the failure of classical theory in the explanation of

a) Atomic spectra

b) Photoelectric effect (6)

20. With a neat diagram, describe the gamma ray microscope experiment to illustrate the Heisenberg's uncertainty principle. (6)

21. Arrive at Schrodinger time independent equation for a free particle in one dimension. (6)

22. Derive an expression for the electrical conductivity of a metal based on classical free electron theory. (6)

23. a) What are miller indices?

    b) Distinguish between continuous and characteristic X-ray spectra. (2+4)

24. With a diagram explain the working of a transistor in CE mode, as amplifier. (6)

25. What is an integrator? Using the circuit diagram, obtain an expression for its output voltage. (6)

PART-D

Answer any FOUR questions. Each question carries 5 marks. (4×5=20)

(Planck's constant h = 6.625×10^{-34} Js, mass of electron m = 9.1×10^{-31} kg, charge on the electron = 1.6×10^{-19}C)

26. In Davisson and Germer experiment, the electrons accelerated through a potential difference of 100 V are incident on a metal crystal of lattice spacing 2.15 Å. Calculate the glancing angle for which the first order diffraction becomes maximum.

27. An electron is confined in a one dimensional box of side 2 Å. How much energy is required to excite the electron from the ground state to the third excited state?

28. The drift velocity of free electrons in a metal wire of diameter 5 mm is $6 \times 10^{-4} ms^{-1}$. The current is 10 A. Calculate the electron density.

29. The Fermi energy of copper is 7.1 eV. Calculate the number of electrons per unit volume.

30. Find the smallest glancing angle at which K_α line of Molybdenum of wavelength 0.5 Å will be reflected from calcite crystal of spacing 3 Å. At what angle will the third order reflection occur?

31. In an OP-AMP, $R_i = 1k\Omega$ and $R_f = 1M\Omega$ and input voltage is 2 mV. Calculate the voltage gain and output voltage in case of

    a) Inverting and

    b) Non- inverting amplifier.

32. a) Convert the decimal number 854_{10} to hexadecimal equivalent.

    b) Convert Hexadecimal number $EC2_{16}$ to binary equivalent.

33. Write the symbol and the truth table for OR and XOR gate.

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V Semester B.Sc. Degree Examination, March/April - 2023

PHYSICS

Statistical, Atomic, Molecular, and Nuclear Physics

(CBCS Semester Scheme Freshers 2020 - 2021 onwards)

Paper : VI

Time : 3 Hours **Maximum Marks : 70**

Instructions to Candidates:

1. All multiple - choice questions in part A are to be compulsory answered in Page 1.
2. Use of Non - programmable scientific calculator is allowed.

PART - A

Answer **All** the questions. Each MCQ carries **1** mark. **(10×1=10)**

1. Phase space has

a) 3 position and 3 momenta coordinates.

b) 3 position and 3 energy coordinates.

c) 3 position and 3 - time coordinates.

d) 3 time and 3 momenta coordinates.

2. According to Heisenberg's uncertainty principle.

a) $dx.dp_x < \hbar$ b) $dx.dp_x \approx \hbar$

c) $dx.dp_x = \pi$ d) $dx.dp_x = \hbar^2$

3. Maxwell - Boltzmann's statistics can be applied to a system of

a) Particles with large potential energy b) Particle with degeneracy.

c) Distinguishable particles. d) Indistinguishable particles.

4. Ratio of the orbital magnetic dipole moment to the angular momentum of the electron is called.
   a) Poisson's ratio. b) Bohr magneton.
   c) Specific charge d) Gyromagnetic ratio.
5. In the vapour state, molecules exhibit.
   a) Only rotational spectra.
   b) Only vibrational spectra.
   c) Both rotational and vibrational spectra.
   d) Only electronic spectra.
6. In stokes lines, the wavelength of the scattered photon is ..... the incident photon.
   a) Greater than b) Less than
   c) Equal to d) One half.
7. Quantization of orientation of electron orbit around the nucleus is called ..... quantization.
   a) Spin b) Spatial
   c) Angular momentum. d) Energy.
8. In β^+ decay ..... particle is emitted.
   a) Proton b) Electron
   c) Positron d) Neutron
9. Can we accelerate a neutron in a cyclotron.
   a) Yes b) No
   c) To a certain extent d) Yes in the reverse direction.
10. Rate of nuclear disintegration depends on
   a) Temperature b) Pressure
   c) Surrounding medium. d) Number of atoms.

PART - B

Answer any **Five** of the following. Each question carries **2** marks. (5×2=10)

11. Mention any two limitations of Maxwell - Boltzmann statistics.
12. Define Fermi level and Fermi energy.

13. Give selection rules for L and S vectors, according to the vector atom model.

14. Mention the different types of spectra exhibited by the molecules.

15. Define α - decay. What is meant by the range of α - particle?

16. Plot the characteristic graph of the GM counter and label its different regions.

17. What is photodisintegration? Explain.

18. Neutrinos are not easily detectable. Why?

PART - C

Answer any **Five** of the folloiwng questions. Each question carries **6** marks. **(5×6=30)**

19. Obtain an expression for the Bose - Einstein distribution function. **(6)**

20. Derive an expression for the probability distribution of particles governed by Fermi-Dirac statistics. **(6)**

21. Explain Somerfield's atomic model give an account of the spinning electron hypothesis. **(6)**

22. Give the quantum theory of the Normal Zeeman effect. **(6)**

23. Explain the Stern - Gerlach experiment. Give its significance. **(6)**

24. Mention the salient features of the β - ray spectrum. How is it accounted for by the neutrino hypothesis. **(6)**

25. Derive an expression for the Q-value of a nuclear reaction. **(6)**

PART - D

Answer any **Four** of the following. Each numerical carries **5** marks. **(4×5=20)**

(Use : $h = 6.625\times10^{-34}$ Js, $m_e = 9.1\times10^{-31}$ kg 3×10^8 m/s, 1amu = 931.5 MeV).

26. Determine the possible ways of distribution of 4 particles in 4 energy levels. If they are

    a. Classical. b. Bosons.

27. Calculate the number of conduction electrons per unit volume in a metal of fermi energy 7.02 eV at T = 0K.

28. The value of Bohr - magneton is 2.727 J/T. Calculate the specific charge of the electron.

29. In the rotational spectra of a molecule the difference between the successive lines is $3.8cm^{-1}$.

    Calculate the moment of inertia and bond length of the molecule. Given : the masses of the two atoms in the molecule to be 2×10^{-26} kg and 2.67×10^{-26} kg. respectively.

30. 5 distinguishable particles are to be distributed in 2 compartments, the first having 3 cells and the second having 2 cells. What is the thermodynamic probability for the macro state (3,2) for Bosons?

31. Calculate the kinetic energy of the α - particle and daughter nucleus, when ${}_{92}U^{238}$ decays into ${}_{90}Th^{234}$. Given : mass of ${}_{92}U^{238}$ = 238.05081 amu, ${}_{90}Th^{234}$ = 234.04363 amu and mass of α - particle = 4.0026 amu.

32. Neutron disintegrates into a proton and a β - particle and releases maximum energy of 0.7819 MeV. If the rest mass of the electron and neutron are 5.4859×10^{-4} amu and 1.0086649 amu respectively, find the mass of the proton.

33. Find the frequency and hence period of the electric field between the Dees of a cyclotron with a magnetic field of 3T used to accelerate protons.

    Given : mass of the proton = 1.66×10^{-27} kg.