

Write the following information in the first page of Answer Script before starting answer

ODD SEMESTER EXAMINATION: 2020-21

Exam ID Number _____

Course _____ Semester _____

Paper Code _____ Paper Title _____

Type of Exam: _____ (Regular/Back/Improvement)

Important Instruction for students:

1. Student should write objective and descriptive answer on plain white paper.
2. Give page number in each page starting from 1st page.
3. After completion of examination, Scan all pages, convert into a single PDF, rename the file with Class Roll No. **(2019MBA15)** and upload to the Google classroom as attachment.
4. Exam timing from 10am – 1pm (for morning shift).
5. Question Paper will be uploaded before 10 mins from the schedule time.
6. Additional 20 mins time will be given for scanning and uploading the single PDF file.
7. Student will be marked as ABSENT if failed to upload the PDF answer script due to any reason.

M.Sc. PHYSICS
THIRD SEMESTER
ELEMENTS OF MODERN PHYSICS
MSP-306 (MDC)

Duration : 3 hrs.

Full Marks : 70

(PART-A : Objective)

Time : 20 min.

Marks : 20

Choose the correct answer from the following:

1X20=20

1. The quantum nature of radiation emerged in an attempt to explain:
 - a. Radioactivity
 - b. Black body radiation
 - c. Interference of light
 - d. Pair production
2. Wein's distribution law could fit the black body radiation curve in the region of:
 - a. Low wavelength
 - b. Middle wavelength
 - c. High wavelength
 - d. None of these
3. If the intensity of the emitted photon is doubled, then:
 - a. The frequency of the emitted photon is doubled
 - b. The number of photon is doubled
 - c. The number of photon reduces to half of the normal state value
 - d. The work-function of the metal is reduced
4. The lowest energy of a quantum particle in a potential well is:
 - a. $E_1 = \frac{\pi\hbar}{2ma}$
 - b. $E_1 = \frac{\pi\hbar}{4ma^2}$
 - c. $E_1 = \frac{\pi^2\hbar^2}{2ma^2}$
 - d. $E_1 = \frac{2\pi^2\hbar^2}{ma^2}$
5. Which of the following process is responsible for lasing action?
 - a. Induced absorption
 - b. Spontaneous emission
 - c. Spontaneous absorption
 - d. Stimulated emission
6. The process of pumping of atoms to their excited level by strong source of light is:
 - a. Electrical pumping
 - b. Optical pumping
 - c. Chemical pumping
 - d. Gas dynamics pumping
7. Which among the following is the empirical formula for the nuclear radius
 - a. $R = r_0 A^{1/3}$
 - b. $R = Ar_0^{1/3}$
 - c. $R = \frac{A}{r_0^{1/3}}$
 - d. $R = \frac{r_0}{A^{1/3}}$
8. The nuclei with same atomic number but different mass number are called:
 - a. Isotopes
 - b. Isotones
 - c. Isomers
 - d. Isobars
9. The de Broglie wavelength is associated with:
 - a. Charge particles
 - b. Sub-atomic particles
 - c. Macroscopic particles
 - d. Electrically neutral particles

10. de Broglie wavelength of a body of mass 'm' and kinetic energy 'E' is:

a. $\frac{2m\hbar}{\sqrt{E}}$
c. $\frac{\hbar}{2mE}$

b. $\frac{\hbar}{\sqrt{2mE}}$
d. $\frac{\sqrt{2mE}}{\hbar}$

11. For a heavy particle ($m = \infty$)

a. $\Delta x \cdot \Delta v_x = \hbar$
c. $\Delta x \cdot \Delta v_x = 0$

b. $\Delta x \cdot \Delta v_x = \infty$
d. $\Delta x \cdot \Delta v_x = \lambda$

12. A nucleus cannot harbor:

- a. A proton
c. A neutron

- b. An α -particle
d. An electron

13. Consider two objects, one is in rest state in centre and other is rotating in a circular orbit with constant speed, the frames of reference associated with them respectively will be:

- a. Inertial, inertial
c. Non-inertial, inertial

- b. Inertial, non-inertial
d. Non-Inertial, non-inertial

14. Which one of the following represents Lorentz transformation? (where $\gamma = 1/\sqrt{1-v^2/c^2}$),

- a. $x' = \gamma(x-vt)$, $y' = y$, $z' = z$ and $t' = \gamma(t - vx/c^2)$
c. $x' = \gamma(x-vt)$, $y' = y$, $z' = 2z$ and $t' = \gamma(t - vx/c^2)$

- b. $x' = \gamma(x-vt)$, $y' = 2y$, $z' = z$ and $t' = \gamma(t - vx/c^2)$
d. $x' = \gamma(x-vt)$, $y' = y$, $z' = z$ and $t' = \gamma(t + vx/c^2)$

15. Which of the following is not related to the special theory of relativity?

- a. Speed of light in vacuum is constant in all inertial frames of reference
c. All the law of physics is same in all inertial frames

- b. Speed of light in vacuum is not constant in all inertial frames of reference
d. None of above

16. An event is defined by:

- a. (x)
c. (x,y,z)

- b. (x,y)
d. (x,y,z,t)

17. If the periodicity is different in different directions then lattice will be:

- a. Crystalline
c. Crystalline and amorphous in particular regions

- b. Amorphous
d. None

18. Primitive cell is defined as if:

- a. The effective number of atoms is one
c. The effective number of atoms is more than one

- b. The effective number of lattice point is one
d. The effective number of atoms is more than one

19. Which of the following represents Tetragonal crystal system?

- a. $a = b = c$
 $\alpha = \beta = \gamma = 90^\circ$
c. $a = b \neq c$
 $\alpha = \beta = \gamma = 90^\circ$

- b. $a \neq b = c$
 $\alpha = \beta = \gamma = 90^\circ$
d. $a \neq b \neq c$
 $\alpha = \beta = \gamma = 90^\circ$

20. Bragg's Law is defined as: (symbols have their usual meaning)

a. $2d \sin \theta = 2n\lambda$

b. $2d \sin \theta = (n/2)\lambda$

c. $2d \sin \theta = n\lambda$

d. $2d \sin \theta = n\lambda$

-- --- --

(PART-B : Descriptive)

Time : 2 hrs. 40 min.

Marks : 50

[Answer question no.1 & any four (4) from the rest]

1. Deduce the de Broglie wavelength for matter waves. 4+2+4=10
Discuss the phase and group velocities.
To produce electrons of wavelength 0.40 \AA , how much voltage must be applied to an electron microscope?
2. What is photoelectric effect? 2+8=10
If the maximum kinetic energy of photoelectrons emitted by photons of wavelength 1800 \AA from a certain metal is found to be 1.5 eV , what is the work function of the metal?
(Given: $h = 6.63 \times 10^{-34} \text{ Js}$, $c = 3 \times 10^8 \text{ m/s}$, $m = 9.11 \times 10^{-31} \text{ kg}$)
3. State Heisenberg's uncertainty principle and give its mathematical expression. 4+6=10
If an electron is confined to a box of length 10^{-9} m , calculate the minimum uncertainty in the measurement of its velocity.
4. What you understand by population inversion? 3+7=10
Discuss the working of He-Ne laser.
5. Discuss the general properties of Nucleus. 7+3=10
If the radius of holmium (Ho^{165}) is 7.731 fermi , deduce the radius of helium (He^4).
6. a. Define inertial and non-inertial frame of reference with a suitable examples. State the postulates of Special theory of relativity. 3+7=10
b. What is Lorentz transformation? Calculate length and orientation of a rod of length 5 meters in a frame of reference which is moving with $0.6c$ velocity in a direction making 30° angle with the rod.
7. a. A clock keeps correct time. With what speed should it be moved relative to an observer so that it may seem to lose 2 minutes in 24 hours ? 5+5=10
b. Define crystal structure using lattice and basis concept.
8. a. What is band theory of solids? Solve the Schrodinger equation for the periodic potential and deduce the expression for Energy (E) versus wave vector (k) relation. 6+4=10
b. Write short notes on the following:
(i) Semiconductors, intrinsic and extrinsic
(ii) Bragg's Law

= = *** = =