PHY1CJ102:ELEMENTS OF MODERN PHYSICS

Section-A-Mark-3

1. List the basic atomic properties
2. Mention the drawbacks of Thomson's model
3. Thomson's atom model is called plum pudding model. Substantiate
4. Discuss the limitations of Thomson's atomic model.
5. Explain Thomson's model of atom
6. Explain distance of closest approach in Rutherford scattering
7. Define impact parameter
8. Summarize how Rutherford tried to rectify problems of Thomson's atom model
9. Differentiate between continuous spectra and line spectra
10. List down the expression for the wavelengths emitted by a hydrogen atom and explain the symbols
11. Name and explain the spectral lines of hydrogen
12. Define Rydberg constant
13. State the aim of Frank-Hertz experiment. Summarize its conclusion
14. Differentiate between excitation energy and ionization energy
15. Explain the mechanism of Frank-Hertz experiment
16. State correspondence principle
17. How did Frank-Hertz experiment validate Bohr model?
18. List the advantages of Rutherford's model over Thomson's model
19. Mention the classifications of line spectra
20. Differentiate between emission spectra and absorption spectra
21. State Ritz combination principle
22. Draw a diagram of Frank-Hertz experimental setup
23. List out the characteristics of hydrogen line spectra

24. State Bohr's postulates of atom
25. Draw the energy level diagram of hydogen atom.
26. Write down the conclusion from the experimental study of scattering of charged particles by atoms.
27. Write down the relation between impact parameter and scattering angle and explain the symbols used.
28. Mention 3 limitations of Rutherford's atom model
29. Explain ether hypothesis
30. Draw labelled diagram of Michelson-Morley experiment
31. Explain the significance of negative result of Michelson-Morley experiment
32. Sustantiate why the result of Michelson-Morley experiment is mentioned as "negative"?
33. State the postulates of special theory of relativity.
34. Write down Lorentz transformation equations
35. Write down inverse Lorentz transformation equations
36. Write down Galilean transformation equations
37. State the consequences of Lorentz transformations.
38. Explain the relativity of time.
39. Explain the relativity of length
40. Explain length contraction in relativity
41. Explain time dilation in relativity
42. Define proper time and proper length
43. Briefly explain twin paradox
44. State the relativistic velocity addition theorem
45. Explain relativistic doppler effect
46. State the conditions under which Lorentz transformation reduces to Galilean transformations and write down the Lorentz transformation equations

47. Explain how time dilation was experimentally verified.
48. Explain how twin paradox was resolved.
49. Discuss about classical relativity
50. Explain how mass varies with velocity in relativity
51. Write down expressions for relativistic momemtum and relativistic energy
52. Write down Einstein's energy mass relation.Explain its significance
53. Give examples of mass-energy conversion
54. Show that the velocity of a massless particle is c
55. Explain Lorentz-Fitzgerald contaction.
56. Write down the energy momentum relation and explain the terms
57. Define electromagnetic wave and its properties?
58. Explain the concept of electromagnetic wave?
59. Explain the properties of Electromagnetic radiation
60. Discuss the concept of constructive and destructive interference
61. State and analyze Braggs law
62. State Braggs law
63. Give some important properties of electromagnetic waves
64. Compare the conditions for constructive interference and destructive interference
65. Explain Photoelectric effect
66. Define Photoelectric effect and photoelectrons
67. Give the expression for Photoelectric equation
68. Discuss the effect of intensity of incident radiation on photoelectric current
69. Explain stopping potential
70. Discuss the effect of potential on photoelectric current
71. Explain threshold frequency

72. Give any two laws of Photoelectric effect
73. Give the expression for the Einstein's Photoelectric equation
74. Analyze the Factors on which the photoelectric Current depends
75. Draw the experimental setup of Photoelectric effect
76. Discuss the phenomenon of Photoelectric effect
77. Explain the Einstein's Photoelectric equation
78. Explain any two Explanation of laws of photoelectric emission from Einstein's photoelectric equation
79. Explain the work function
80. Give the expression for work function
81. Explain the concept of black body radiation
82. Define black body radiation
83. Give the expression for the Rayleigh- Jeans formula
84. give the expression for the Weins displacement Law
85. Explain concept of the thermal radiations
86. Explain the depends of wavelength and temperature of Thermal radiation
87. a cavity is maintained at a temperature of 1650K. At what rate does energy escape from the interior of the cavity through a hole in its wall of diameter 1 mm
88. a cavity is maintained at a temperature of 1000K. At what rate does energy escape from the interior of the cavity through a hole in its wall of diameter 2 m
89. Give the expression for Planck's Radiation Law in terms of frequency.
90. Give the expression for Planck's Radiation Law in terms of wavelength.
91. Give the expression for Stefan's Law in terms of wavelength.
92. Explain photoelectric effect and work function
93. Explain Compton effect
94. Define Compton wavelength

95. Analyze the concept of Compton shift
96. Give the expression for Compton shift
97. Explain Compton shift
98. Distinguish Photoelectric effect and Compton effect
99. Explain Bremssrahlung
100. Distinguish between x-rays and Bremssrahlung x-rays
101. Give the equation representing the pair production
102. Explain Photon emission and photon absorption
103. Differentiate pair production and pair annihilation
104. Discuss the properties of photon
105. Explain the dual nature of light
106. Discuss the nature of light
107. Explain the photon absorption
108. Discuss theory of pair production and pair annihilation
109. Explain the significance of matter wave
110. Define De Broglie waves. Give any two properties
111. State de Broglie's hypothesis?
112. Give the properties of De Broglie Waves.
113. Write down the de Broglie formula and give any three concluions about De Broglie waves from that formula
114. Mention any four characteristics of matter waves
115. Explain matter waves
116. State the aim of Davisson and Germer experiment
117. Explain the experimental setup of Davisson and Germer experiment
118. How did Davisson and Germer experiment validate wave like nature of particles
119. Draw the experimental setup of Davisson and Germer experiment.

120. Why don't we observe wave nature of objects in the real world?
121. State and explain uncertainty relationship for classical ways in terms of wavelength
122. Analyze the uncertainty relationship for classical ways in terms of frequency
123. Derive the expression for uncertainty relationship for classical waves in terms of wavelength
124. Derive the expression for uncertainty relationship for classical waves in terms of frequency
125. State the Heisenbergs Uncertainty relationships
126. Derive the Heisenbergs Uncertainty principle I
127. Derive the Heisenbergs Uncertainty principle II
128. State the Heisenbergs position momentum Uncertainty principle.
129. State the Heisenbergs Energy time Uncertainty principle.
130. Define wave packets. Give any two properties
131. Define Phase velocity
132. Define Group velocity
133. Write down the expressions for phase velocity and group velocity
134. Explain group velocity and phase velocity. Give the relationship between group velocity and Phase velocity
135. Explain the concept of randomness
136. Distinguish between group velocity and phase velocity
137. Define probability amplitude and probability density

Section-B-Mark-6

1. Write down the Bohr's postulates of an atom
2. Derive an expression for the velocity of orbital electron according to Bohr model
3. Explain the deficiencies of Bohr model
4. Explain in detail Thomson's model of an atom and its limitations

5. Find out the distance of closest approach when alpha particles of kinetic energy 6 MeV are scattered by a thin copper foil(Z=29) foil?
6. Briefly explain scattering of alpha particle experiment
7. Give a short note on spectral series of hydrogen atom
8. Explain absorption and emission spectra
9. How much energy is required to remove an electron in n=2 state from a hydrogen atom?
10. What is the shortest wavelength emitted by Balmer series in hydrogen spectrum?
11. Explain Frank-Hertz experiment
12. Calculate the shortest wavelength limit of Lyman series.
13. Calculate the longest wavelength limit of Lyman series
14. Compute the oscillation frequency of the electron in Thomson model hydrogen atom.Use R=0.053 nm. Compare with the observed wavelength in hydrogen which is 122 nm.
15. Find out the distance of closest approach when alpha particles of kinetic energy 5MeV are scattered at 90 degree by a copper foil(Z=79) foil?
16. How much kinetic energy must an alpha particle have before its distance of closest approach to a gold nucleus is equal to the nuclear radius is 7.0x10 -15m?
17. The shortest wavelength of Lyman series is 91.13 nm. Find the three longest wavelength in the series.
18. One of the lines in Brackett series(series limit=1458 nm) has a wavelength of 1944 nm. Find the next higher and next lower wavelengths in this series.
19. Derive an expression for the radius of orbit according to Bohr model
20. In n=3 state of hydrogen, find electron velocity, kinetic energy and potential energy.
21. Use the Bohr theory to find the series wavelength limits of the Lyman and Paschen series of hydrogen.

22. An electron is in the n=5 state of hydrogen. To which states can the electrons make transitions and what are the energies of emitted radiation.
23. Calculate the wavelength of transition emitted when He+ makes a transition from ni=3 to the state nj=2.
24. Derive expression for total energy of an electron in the orbit
25. Calculate the ionisation energy of the ground state of Li++ atom.
26. Calculate the shortest and longest wavelength limits of Lyman series.R=1.097X10 7 m-1
27. Explain Michelson-Morley experiment
28. Deduce Lorentz transformation equation for position
29. Deduce Lorentz transformation equation for time
30. Give a mathematical explanation for length contraction
31. Give a mathematical explanation for time dilation
32. A rocket is 40 m long on the ground. When it is in flight its length is 38 m to an observer on the ground. Find the speed of the rocket
33. A spacecraft of length 125 m is moving with a speed 0.98 c. What is its length with respect to an observer on earth?
34. A 200m long train has to pass through 150 m long tunnel. If the train moves towards the tunnel with a speed 0.8 c,find the length of the train and tunnel as seen by a man a)at the train b)at the tunnel
35. A rocket is 100 meter long on earth. When it is in flight its length is 98 metres to an obsever in space laboratory. Compute the speed of the rocket.
36. Explain the experimental verification of time dilation
37. Mesons has mean life of 2x10-6 s. What is the mean life when it is moving with a speed 0.98 c. How far does it travel in this time?
38. Nikhil is 20 years old and his father Vinod is 50 years old. Vinod travels in a spaceship and comes back to Earth. On returning from the spaceship, Vinod finds himself only 60 years old whereas his son became 70 years old on earth. Calculate the velocity of the ship

39. How much younger an astronaut will appear to an observer on Earth if he returns after one year having moved with a velocity 0.8 c.

40. Calculate the mass of a particle whose kinetic energy is half its total energy. Find its speed

41. Two particles come towards each other with a speed 0.8 c with respect to a laboratory on earth. Find their relative speed

42. Derive Lorentz velocity transformation equations

43. Show that a particle moving with zero rest mass is always moving with the speed of light.

44. A proton of rest mass 1.67x10-7 kg moves with a velocity c/√2. Fnd its mass,momentum,total energy and kinetic energy

45. Two particles come towards each other with a speed 0.7 c with respect to a laboratory on earth. Find their relative speed

46. A star is 10 light years away from earth. How long would it take for a spaceship travelling with a velocity 3x10 6 to reach the star with respect to an observer on the spaceship

47. A particle is moving with a speed of 0.4 c. Find the ratio of rest mass and the mass in motion.

48. Deduce the expression for relativistic momentum.

49. Deduce the expression for relativistic energy.

50. Deduce the relation between relativistic energy and momentum

51. Show that a clock moving with a very high velocity runs slow with respect to a stationary clock

52. Anu is 25 years old and her father Anand is 50 years old. Anand travels in a spaceship and comes back to Earth. On returning from the spaceship, Vinod finds himself only 60 years old whereas his son became 65 years old on earth. Calculate the velocity of the spaceship

53. Explain the properties of electromagnetic radiation

54. Derive Braggs law

55. Explain the concept of indifference and diffraction

56. Light of wavelength 5000Å falls on a sensitive plate with photoelectric work function 1.9eV. Find (i) energy of the photon (ii) kinetic energy of photoelectrons emitted and (iii) stopping potential. h = 6.62 x 10 ^ - 34 Js

57. Work function of sodium is 2.3eV. Does sodium show photo electric emission for orange light of wavelength 6800 Å. Given h = 6.62 x 10 ^ - 34 Js

58. Calculate the velocity of photoelectron when a light of wavelength 2000Å is incident on a metal surface. Work function of the metal is 2.5eV, mass of electron = 9.1 x10 ^ - 31 kg

59. Explain Photoelectric effect

60. Discuss photoelectric effect and Einstein's Photoelectric equation

61. Discuss the laws of Photoelectric effect

62. Disuss the explanation of laws of Photoelectric emission from Einstein's Photoelectric equation

63. Analyse the factors which effect the photoelectric current

64. Explain the experimental setup of Photoelectric effect

65. Explain and analyse Einstein's Photoelectric equation

66. Analyse Photoelectric effect with the suitable diagram

67. Explain and analyse the concept of thermal radiation

68. Analyse the experimental set up to study thermal radiation

69. Analyze the dependentce of wavelength and temperature in thermal radiation.

70. Discuss black body radiations

71. Distinguish Classical and Quantum theory of black body radiation.

72. Discuss the Compton effect

73. Derive the expression for Compton shift and analyse the expression for it.

74. Derive the expression for Compton shift

75. X-rays of wavelength 0.140nm are scattered from a block of carbon. What will be the wavelength of X-rays scattered at a)0o b)90o c)180o a) 0^{o} b) 90° and c) 180°

76. The wavelength of a photon is equal to the compton wavelength of electron. What is its energy.

77. X-rays with an energy of 50 keV are scattered by 45°. Find the frequency of the scattered photon.

78. Distinguish pair production and pair annihilation

79. Explain the concept of Pair production and pair annihilation

80. Analyze how atoms intract with photons.

81. Distinguish between Photon emission and photon absorption

82. Explain the experimental set up to study thermal radiation

83. Discuss de-broglie hypothesis and obtain the expression for de-broglie wavelength

84. Derive de-broglie wavelegth in terms of potential

85. Calculate the de Broglie wavelength of (i) a rifle bullet of mass 2g moving with a speed of 400m/s and (ii) a 2000kg car moving along the highway at $30ms^{1}$

86. Calculate the de Broglie wavelength associated with a proton moving with a velocity equal to 1/20 th of the velocity of light.

87. What is the energy of the gamma ray photon having wavelength of 1 Ao

88. Explain Davisson-Germer experiment

89. How did Davisson-Germer experiment validate wave-nature of particles

90. Explain the experimental setup and results of Davisson-Germer experiment

91. In the Davisson-Germer experiment using a Ni crystal a second order beam is observed at angle of 55°. For what accelerating voltage does this occur.

92. Derive the expression for uncertainty relationship for classical waves in terms of wavelength and frequency

93. In a measurement of water waves 10 wave cycles are counted in a distance of 196 cm. estimate the minimum uncertainty in the wavelength that might be obtained from this experiment. Take epsilon = 0.1

94. Explain Davisson-Germer experiment with suitable diagram

95. Derive the uncertainty relation between frequency and time for a classical wave.

96. Derive the uncertainty relation between position and wavelength for a classical wave.

97. Sound waves travel through air at a speed of 330m * s ^ - 1 . A whistle blast at a frequency of about 1.0 kHz lasts for 0.2 s.a) Over what distance in space does the wave train representing the sound extend.b) What is the wavelength of the sound.e) Estimate the precision with which an observer could measure the wavelength.d) Estimate the precision with which an observer could measure the frequency.

98. Explain and analyse Heisenberg's uncertainity relationships

99. State and explain Heisenberg's uncertainity principle I and II

100. An electron is confined to a region of space of the size of an atom (0.1 nm).a) what is the uncertainty in the momentum of the electron.b) what is the kinetic energy of an electron with a momentum equal to Δp

101. An electron is confined to a region of space of the size of an atom (0.2 nm).a) what is the uncertainty in the momentum of the electron.b) what is the kinetic energy of an electron with a momentum equal to Δp

102. Define phase velocity and group velocity. Analyse its significance

103. Compare phase velocity and group velocity and derive the relationship between them.

104. Show that the group velocity and the particle velocity are the same in the case of nonrelativistic as well as relativistic-particles.

105. Show that phase velocity is half of group velocity

106. Show that product of phase velocity and group velocity is equal to the square of velocity of light.

Section-C-Mark-10

1. Explain Bohr's model of hydrogen atom.

2. Describe Bohr model of an atom. Derive an expression for the energy levels of hydogen atom and draw the energy level diagram.

3. Derive expressions for total energy of an electron,radius of the orbit,velocity of the orbital electron,wavelength of radiation emitted according to Bohr model

4. Describe Michelson-Morley experiment and explain the significance of the negative result explained.
5. Deduce Lorentz transformation equations.
6. Using Lorentz transformation equations explain Lorentz-Fitgerald contraction and time dilation.
7. Deduce Lorentz transformation equations for velocity and state relativistic doppler effect
8. Derive energy momentum relation in relativity
9. Show that a clock moving with a very high velocity runs slow with respect to a stationary clock and give its experimental verification
10. Explain relativistic addition of velocities and relativity of length
11. Explain relativity of time and twin paradox in relativity
12. Derive expressions for relativistic momentum and energy
13. Describe the phenomenon of photoelectric effect. Give the quantum interpretation of the effect. Write down photoelectric equation and explain the terms used.
14. Explain the phenomenon of Photoelectric effect and analyse the Photoelectric equation
15. Obtain the Compton shift for a photon incident on a free electron.
16. Explain what is meant by compton effect. Derive an expression for compton shift.
17. Analyse with suitable diagram explain the Compton effect. Derive the expression for Compton shift
18. Explain the theory of Compton effect and validate it with necessary expressions.
19. Analyse with suitable diagram explain the Compton effect and Compton Shift
20. Explain the theory of Compton effect and derive the expression for the Compton shift.
21. describe the phenomenon of the Compton effect. and analyse the expression for Compton shift.

22. Describe Davisson-Germer experiment
23. Derive uncertainity relationships for classical waves
24. Obtain Heisenberg's uncertainity relationships
25. Explain de-broglie hypothesis and analyse its significance
26. Compare group velocity and phase velocity and derive a relationship between them
27. Analyse the results of Davisson-Germer experiment