PHY3C03:MECHANICS, RLATIVITY, WAVES AND OSCILLATIONS

A Part

1. What is a frame of reference?
2. What is transformation equation?
3. Mention two properties of an inertial frame of reference
4. Explain the invariance of a physical quantity under Galilean transformation
5. Define inertial frame of reference
6. Mention two physical quantities which are invariant under Galilean transformation
7. What are the Galilean velocity transformation equations?
8. Explain Non-inertial frame of reference
9. What are different types of frames of reference?
10. Why a person sitting in a car is pushed towards the door when the car takes a sharp turn?
11. In which frame of reference fictitious force acts? Give one example.
12. Cyclones do not occur at the equator. Explain
13. What is meant by invariance of Galilean transformation ?
14. Explain weightlessness in a lift.
15. Define non-inertial frame of reference. Give one example.
16. What is a fictitious force? Give one example.
17. What are the fictitious forces present in a rotating frame of reference?
18. Show that apparent weight of a man in a lift is decreased if it is moving downwards with an acceleration.
19. What is centrifugal force?
20. What is Coriolis force?
21. State work-energy theorem.
22. What are different equilibrium points on a potential energy curve?
23. Define potential energy curve. Under what condition a particle in that well can escape?
24. Distinguish between positive and negative work. Give one example to both.
25. Show that curl of a conservative force is zero.
26. Define conservative force. Give two examples
27. State and explain the law of conservation of mechanical energy.
28. Define non-conservative force. Give two examples
29. Express the conservative force as the negative gradient of a potential

30. What are the properties of conservative force?
31. What is the difference between conservative and non-conservative force? Give examples
32. Explain how conservative force is related to potential energy.
33. State law of conservation of linear momentum
34. Give the mathematical representation for law of conservation of linear momentum.
35. Explain the conservation of linear momentum.
36. The C-frame is called zero reference frame. Explain
37. What is centre of mass frame of reference? Is it an inertial frame or non-inertial frame of reference?
38. What are the conditions required to attain high velocity for rocket propulsion?
39. Provide a mathematical expression for the velocity of centre of mass of a particle.
40. Provide a mathematical expression for the position of centre of mass of a particle.
41. What is central force? Give one example.
42. What are the characteristics of central force?
43. Give two examples of conservation of angular momentum.
44. Show that angular momentum of a satelite moving in a circular orbit around the earth is conserved.
45. Explain the hypothesis of ether.
46. Why the result of Michelson-Morley experiment is mentioned as “negative”?
47. State the postulates of special theory of relativity.
48. Why ether hypothesis was discarded?
49. Explain the consequences of Lorentz transformation equations
50. What are Lorentz transformation equations?
51. What are Lorentz transformation equations?
52. What is meant by time dilation?
53. What is ‘Twin paradox’?
54. Define proper length.
55. What is meant by length contraction?
56. Explain the experimental verfication of time dilation.
57. Define proper time.
58. Explain the variation of mass with velocity
59. Write down the variation of mass the velocity and explain the symbols
60. Write down the relativistic velocity transformation equations

61. Show that a particle of finite mass cannot move with the velocity of light.
62. From the relativistic energy-momentum relation, show that photon can travel with the velocity of light.
63. Write down the mass-energy relation and explain the symbols
64. Write down the mass energy relation and explain the symbols
65. Distinguish between Pair Production and Annihilation.
66. Write down the energy momentum relation and explain the symbols
67. Write down the energy momentum relation and explain the symbols
68. Give mathematical expression for the period of oscillation of a loaded spring
69. What are the characteristics of S.H.M ?
70. What is an oscillatory motion? Give two examples.
71. What is simple harmonic motion?.Give expression for displacement of the particle.
72. Write down the expression for kinetic energy of particle executing SHM
73. What are characteristics of Anharmonic oscillator
74. Write down the differential equation for a damped harmonic oscillation and explain the symbols.
75. What is meant by damped oscillations?.Give expression for its damped motion
76. Write down the equation of motion for Anharmonic oscillator
77. What is meant by (i) Free oscillation (ii) Damped oscillation?
78. Define wave motion.
79. What is a progressive wave. Write down the equation of a progressive wave moving along x-direction in terms of T and wavelength λ.
80. Write down the general equation of wave motion.
81. Light is a transverse wave. Explain
82. Distinguish between transverse and longitudinal waves with suitable examples.
83. Distinguish between transverse and longitudinal waves. Give two example for each
84. What is meant by periodic motion?
85. What is meant by energy density of a plane progressive wave.
86. What is meant by energy density of plane waves?
87. Define electromagnetic wave and its properties?
88. What is a black body? Define black body radiations?
89. What is ultraviolet catastrophe?
90. What is an electromagnetic wave? What are its properties?

91. Draw the graph showing the variation of frequency of black body radiation at a temperature with the spectral energy density.
92. Write down any 3 properties of electromagnetic waves.
93. Explain two laws of photoelectric emission from Einstein's photoelectric equation.
94. What is Einstein's Photoelectric equation ? Explain the symbols.
95. What is work function? How is it related to the frequency of incident photon?
96. What is threshold frequency ? Wite down the relation between work function and threshold frequency.
97. What is stopping potential?
98. How does the photoelectric effect provide evidence for the particle nature of light?
99. What is photoelectric effect and work function?
100. How does the frequency of light affect the emission of electrons in the photoelectric effect?
101. What is photoelectric workfunction? Write down Einstein's photoelectric equation.
102. What are the laws of the photoelectric effect?
103. Write down the uncertainty relations and explain the symbols
104. What is the significance of the uncertainty principle in quantum mechanics?
105. Explain the uncertainty principle
106. What is the Heisenberg Uncertainty Principle?
107. What is de Broglie's phase velocity?
108. Explain wave-particle duality of matter
109. What is meant by quantum theory of light?
110. How does the uncertainty principle relate to wave-particle duality?
111. What is phase velocity, and how is it defined mathematically?
112. State the hypothesis of de Broglie
113. What is group velocity, and what is its significance in wave propogation?
114. What is group velocity?
115. Can the uncertainty principle be applied to energy and time? If so,how?
116. What is meant by eigen value equation? Explain with an example
117. Define eigen value equation
118. Explain the uncertainty principle concerned with energy and time.
119. Define momentum and energy operators
120. What are momentum and energy Operators?
121. Write down the uncertainty relations and explain the symbols

122. Write down the time dependent and time independent Schrodinger equation. Explain the symbols

123. What is the importance of Schrodinger's time dependent equation?

B Part

124. Derive Galilean transformation equations.

125. Use Galilean transformation to show that the distance between two points (x_1, y_1, z_1) and (x_2, y_2, z_2) is invariant in two inertial frame.

126. Show that acceleration is invariant under Galilean transformation.

127. Show that length is invariant under Galilean transformation.

128. A lift is moving upwards with an acceleration 2g. Compute the effective weight of a man standing in it, when his actual mass is 70kg.

129. Distinguish between real force and fictitious force with suitable examples

130. An astronaut weights 350 kg in a moving rocket. If the rocket is going upwards with an acceleration 4g, find the weight of the astronaut in the laboratory.

131. Earth is not an inertial frame of reference. Explain

132. A stone of mass 1 kg is tied at the end of a string of length 2m makes 2 revolutions per second. Calculate the forces on the stone as measured in a inertial frame and frame which is rotating with the string.

133. Explain the apparent deflection of moving objects towards right in the Northern hemisphere

134. What is the effect of coriolis force due to rotation of earth?

135. Show that total mechnical energy of the particle remains constant in a conservative field

136. Describe the potential energy curve.

137. A particle is moving in a potential energy field $U=A-Bx+Cx^2$. What is the restoring force on the particle? At what point does this force vanish? What is the nature of equilibrium at this point?

138. What is potential energy curve? Explain potential well.

139. Explain work-energy theorem. Using this theorem derive an expression for kinetic energy.

140. What is a conservative force? State atleast three characteristics.

141. Show that the work done by a conservative force in a closed path is zero. Show that the force $F=(y^2-x^2)$ **i**$+2y$ **j**$+ 4z$ **k** is conservative

142. Show that the force $F = i(y^2-x^2) + j2y + k4z$ is conservative.

143. Show that in the absence of external forces total linear momentum is always conserved.

144. Define law of conservation of linear momentum. Give its mathematical epresentation. Also explain the condition under which this law remains valid

145. A shell at rest explodes into three pieces of mass in the ratio 1:1:2. If the two pieces of equal mass flyoff with a speed each of 10m/s perpendicular to each other, what is the speed of the third heavier piece?

146. A single stage rocket consumes 80 kg of fuel per second exhausting it with a speed of 5km/s. Find the thrust on the rocket. If the rocket starts from rest what will be its velocity when mass of the rocket

reduces to (1/10) of its inintial mass?

147. Two particles of masses m_1 and m_2 are separated by a distance. Show that the ratio of the distances of their center ofmass is equal to the inverse ratio of their masses.

148. Derive an expression for final velocity of a rocket.

149. Show that areal velocity of the particle moving under central force field remains constant.

150. Explain the principle behind bending the out stretched arms while rotating in a table.

151. Show that a particle moving in a conservative force field is always restricted to move in a plane.

152. In Michelson-Morley experiment the distance from partially silvered glass plate to each of the mirrors was 11m. If the wavelength of light used was 6000Å and the expected fringe shift was 0.4. Find the velocity of earth relative to ether.

153. Show that $x^2+y^2+z^2-c^2t^2$ is Lorentz invariant.

154. Derive Lorentz velocity transformation equations.

155. Compute the speed of a rocket whose clock run one second slower per hour relative to a clock on the earth.

156. (a) What is the mean life of mesons travelling with v = 0.73c, if the proper mean life time is $2.3x10^{-8}$? (b) What is the distance travelled at v=0.73c during one mean life? (c) What distance will be travelled without relativistic effect?

157. Show that kinetic energy of a particle is $(m-m_0)c^2$ in relativistic mechanics.

158. A rocket is 100 m long on earth. When it is in flight its length is 98 m to an observer in space lab. Compute the speed of rocket.

159. Derive the expression for time dialation.

160. How much younger an astronaut will appear to the earth observer if he returns after one year having moved with a velocity 0.8c.

161. A square of side of length 'a' is moving with a speed c/2 parallel to one of its sides. What is its area in motion?

162. A stationary bomb explodes in to two fragments of rest mass 1kg each moving apart with a speed of 0.6c. Find the rest mass of the bomb.

163. Calculate the speed at which the mass of an electron becomes 4 times its rest mass

164. Derive mass energy relation

165. Calculate the mass of an electron accelerated to a kinetic energy of 2MeV. $m_0=9.1x10^{-31}$ kg

166. Define SHM and give 2 examples. Derive time period of oscillation of loaded spring.

167. Define Simple harmonic motion. Derive differential equation of SHM and find its solution

168. When a mass is hung from the lower end of a spring of negligible mass an extension of 9.8 cm is produced in the spring. The mass is set into vertical oscillation. Find the period of oscillation.

169. Derive the expression for the time period of a loaded spring.

170. Derive Simple harmonic motion. Derive differential equation of SHM and obtain the expression

171. A meter stick is suspended from one end and set swinging. What is the period of the resulting oscillation assuming they makes small oscillations

172. Derive the expression for the time period of a simple pendulum.

173. For a damped oscillator, the mass m of the block is 200g. Force constant=10N/m and the damping constant is 40g/S. Calculate the period of oscillation if oscillatory

174. Define damped oscillations and derive differential equation of damped oscillations.

175. What is meant by damped oscillations ?. Obtain an expression for its motion.

176. Write a short note on Anharmonic oscillator and free oscillations.

177. A simple harmonic oscillator has velocity 10m/s at 4cm and 4m/s at 10cm from the centre of motion. Calculate amplitude and time period of oscillation?

178. Derive an expression for plane progressive harmonic wave.

179. Define plane progressive harmonic wave. Obtain the equation of plane progressive harmonic wave and its periodicity.

180. Show that the average kinetic energy per unit volume over a period of progressive wave is equal to half of the total energy of the wave.

181. Sun radiates energy at a rate of $3.8*10^{-26}$ W. What is the intensity of solar radiation incident on the earth while it is $1.5x10^{11}$m away from the sun.

182. Explain ultraviolet catastrophe. What was the result of this discrepancy?

183. Explain ultraviolet catastrophe. What was the result of this discrepancy?

184. Write a short note on blackbody and blackbody radiation.

185. The maximum wavelength for photoelectric emission in tungsten is 230 nm. What wavelength of light must be used in order for electrons with a maximum energy of 1.5eV to be ejected?

186. Define stopping potential. Show graphically that stopping potential depends only on the frequency of incident radiations and is independent of the intensity of radiations.

187. Describe Photo electric effect.

188. Draw the graph between maximum KE and the frequency of incident photon for a metal surface. Determine the work function from this graph.

189. What is a wave group? Explain the uncertainty principle in position and momentum using wave group.

190. If the average time period between the excitation of an atom and the emission of photon is 10^{-8} S. Find the uncertainity in the frequency of emitted photon.

191. Determine the de-Broglie wavelength associated with an electron moving with a velocity 0.6c and rest mass $9.1*10^{-31}$ kg.

192. Explain de Broglie hypothesis. What is the difference between De-Broglie's phase velocity and group velocity.

193. Derive the eigen value equations for momentum and total energy of a free particle. Define energy and momentum operators.

194. An eigen function of the operator $\frac{d^2}{dx^2}$ in wavefunction ϕ=$e^{-2x.}$ Find the corresponding eigen value

195. Define energy and momentum operators.

196. Give expression for time dependent and time independent Schrodinger equation. Explain it's importance.

C Part

197. Derive Galilean transformation equations and hence deduce that length is invariant under Galilean transformation

198. What ia a non inertial frame of reference. What are the fictitious forces arise in a non inertial frame.

199. What are fictious forces in a non-inertial frame. Derive the expressions for the same.

200. (a) Explain the potential energy curve of a particle in one dimension. Obtain conditions of equilibrium of the particle.
(b) Define potential well. Using Taylor's series expansion of potential energy derive an expression for potential energy of harmonic oscillator.

201. Derive an expression for potential and kinetic energy of a simple harmonic oscillator and draw the graphical variation of energy with displacement.

202. Describe Potential energy curve of a particle in one dimension and discuss the equilibrium conditions.

203. Explain the principle of rocket. Derive the expression for maximum velocity attained by a rocket (a)neglecting the weight of the rocket and b) taking into account the weight of the rocket.

204. Define central force. Show that angular momentum of a particle in central force field is conserved. (b) Show that areal velocity of the particle moving under central force field remains constant.

205. Describe Michelson-Morely experiment and explain the significance of the null results obtained.

206. (a) Derive Einstein's mass energy relation.
(b) Deduce an expression connecting relativistic energy and momentum.

207. Explain the Michelson Morley experiment with neat diagram.

208. State the postulates of special theory of relativity and hence derive the Lorentz transformation equations.

209. Derive an expression for time dialation; discuss its experimental verification, and explain the 'Twin paradox'.

210. Explain the consequences of Lorentz transformations

211. Derive the expression for relativistic variation of mass with velocity

212. Define Simple harmonic motion. Show that oscillation of a loaded spring are simple harmonic in nature and obtain an expression for the time period.

213. Define Simple harmonic motion. Show that oscillation of a simple pendulum is simple harmonic in nature and obtain an expression for the time period.

214. What is a damped oscillator? Set up the differential equation of a damped harmonic oscillator.

215. Derive an expression for energy density of a plane progressive wave.

216. Explain with neat diagram the phenomenon of Photoelectric effect.

217. Explain the laws of Photoelectric effect. Draw the graphs connecting variation of photo electric current with frequency and intensity.

218. (a) What is Photo electric effect? (b) What are the laws of photo electric effect? (c) Derive Einstein's photo electric equation.