QUESTION BANK IN PHYSICS

EM WAVES

1. Write Maxwell's equations in differential form. (2) {JUN 15 [GNE]}
2. Derive Maxwell's electromagnetic wave equation for a non-conducting medium. (4) {JUN 15 [GNE]}
3. Show that electrostatic field is equal to the negative of potential gradient and hence show that electrostatic field is conservative. (4) {JUN 15 [GNE]}
4. What is the physical significance of divergence of of a vector field? (2) {JUN 15 [PTU]}
5. Show that divergence of curl of a vector always vanishes. (2) {JUN 15 [PTU]}
6. What is Poynting vector and give its significance? State and prove Poynting vector theorem. (6) {JUN 15 [PTU]}
7. Write differential form of Maxwell's equations applicable in material medium. (2) {JUN 15 [PTU]}
8. What do you mean by displacement current? (2) {DEC 14 [GNE]}
9. Show that velocity of plane electromagnetic waves in free space is given by $c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$. (4) {DEC 14 [GNE]]}
10. Using Maxwell's equations prove that $\vec{\nabla}.\vec{J} + \frac{\partial \rho}{\partial t} = 0$. (4) {DEC 14 [GNE]}
11. What is the physical significance of gradient of a scalar field? (2) {DEC 14 [PTU]}
12. What information does the quantity Poynting vector furnish? (2) {DEC 14 [PTU]}
13. State and prove Poynting vector theorem. Give significance of each term. (4) {JUN 15 [PTU]}
14. Derive differential form of ampere's circuital law for (i) steady currents and (ii) varying currents. (4) {JUN 14 [GNE]}
15. Derive Maxwell's electromagnetic wave equation for linear, isotropic and homogeneous medium. Hence prove that these waves can travel in vacuum. (4) {JUN 14 [GNE]}
16. Define Poynting vector. Give its significance. (2) {JUN 14 [GNE]}
17. What is the origin of displacement current density? (2) {JUN 14 [GNE]}
18. State and explain Ampere's law and express it in differential form. Further explain how Maxwell modified this law to accept this as one of the Maxwell's equations. (6) {JUN 14 [PTU]}
19. Give one example for each of a solenoidal and irrotational vector field. (2) {JUN 14 [PTU]} (2) {JUN 14 [PTU]}
20. Differentiate between steady current and static current. (2) {Dec 2013 [PTU]}
21. State Faraday's laws of electromagnetic induction. (2) {Dec 2013 [PTU]}
22. (i) Write down Maxwell's equations in free space. (ii) Explain introduction of displacement current by Maxwell. (iii) Show that the velocity of plane

electromagnetic waves in free space is given by $c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$. (4) {Dec 2013 [PTU]}

23. Derive Maxwell's electromagnetic wave equation and hence find the velocity of light in vacuum. (4) {Dec 2013 [GNE]}
24. The surface charge density of a charging capacitor is increasing with time as $\sigma = 3t^2 Cm^{-2}$. What will be the value of displacement current at $t = 2 \cdot 5s$. Given that the area of each plate is $2cm^2$. (4) {Dec 2013 [GNE]}
25. What do you understand by electromagnetic spectrum? (2) {Jun 2013 [PTU]}
26. Define Poynting vector. (2) {Jun 2013 [PTU]}
27. Differentiate between conduction current and displacement current by taking suitable example(s). (2) {Jun 2013 [PTU]}
28. Give an example of lamellar and solenoidal vector fields. (2) {Jun 2013 [GNE]}
29. Define divergence of a vector field. Write its expression in terms of Cartesian coordinates and discuss its physical significance. (4) {Jun 2013 [GNE]}
30. Use Maxwell's equations to deduce wave equations in terms of $\vec{E}$ & $\vec{H}$ field vectors for free space. (4) {Jun 2013 [GNE]}
31. What is the significance of divergence and curl of a vector? (2) {Dec 2012 [GNE]}
32. Write Maxwell's equations and discuss their significance. (4) {Dec 2012 [GNE]}
33. In an electric field, the potential is given as $V(x, y, z) = \sqrt{4x^2 + 3y^2 + 9z^2}$ Volt. Calculate electric field at the point (1,2,3). (4) {Dec 2012 [GNE]}
34. Write the physical significance of gradient of a scalar function. (2) {Dec 2012}
35. "Maxwell's equations are reformulation of existing laws." Comment and justify your answer. (5) {Dec 2012}
36. What is the utility of Maxwell's equations in reference to electromagnetic waves? (2) {June 2012}
37. What do you mean by displacement current? (2) {June 2012}
38. Deduce Maxwell's equation Faraday's laws of electromagnetic induction. (4) {June 2012}
39. In free space, the electric field variation due to electromagnetic waves is given by: $E(x, t) = 50\cos[(\omega t - \beta x)a_y]\ Vm^{-1}$. Find the average power crossing a circular area of radius 5mm in the plane $x = \text{constant}$. (4) {June 2012}
40. Write Maxwell's equations for free space. (2) {Dec 2011}
41. What do you mean by electromagnetic spectrum? (2) {Dec 2011}
42. What is modified Ampere's law? Discuss its significance in terms of Maxwell's theory and obtain an expression for displacement current density. (5) {Dec 2011}
43. Curl of a vector field represents whirling/rotational features of the field. Justify. (3) {Dec 2011}
44. Write Maxwell's equations in differential form. (2) {June 2011}
45. Write down Maxwell's equations and explain their significance. (4) {June 2011}
46. What is the differential form of Gauss's Law? (2) {Dec 2010}
47. Write down Maxwell's equations and explain their physical significance. (4) {Dec 2010}

48. Show that the velocity of plane electromagnetic wave in free space is given by $c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$. (4) {Dec 2010}
49. State and explain Ampere's circuital law and express it in differential form. Further explain how Maxwell modified this law to accept this as one of the Maxwell's equations. (5) {June 2010}
50. The electrostatic potential in a certain region is given as $V(x, y, z) = 3x + 4y - 6z$. Obtain the expression for corresponding electric field strength. (3) {June 2010}
51. Explain the significance of Maxwell's Equations. (4) {Dec 2009}
52. Derive the relations for Maxwell's equations. (8) {June 2009}
53. Give the physical significance of Maxwell's equations. (4) {Dec 2008}
54. Is displacement current like conduction current a source of magnetic field? (2) {May 2008}
55. State Ampere's circuital law and discuss why it was modified to include the displacement current? (2) {May 2007}
56. Show that isolated magnetic poles do not exist. (2) {Dec 2006}
57. The electric potential in a certain region is given by: $V(x) = 10x^2 + 20y + 5z^3$ in SI units. Calculate the electric field at a point P(2,3,1) in SI units. Is this field uniform? (2) {May 2004}
58. Explain the meaning of gradient of a scalar field. (2) {Dec2003}
59. Write down Maxwell's equations and state the laws of electrodynamics to which these correspond. Deduce the wave equation for electromagnetic waves in free space. (3) {Dec2003}

CRYSTALLOGRAPHY

1. Why X-rays are most suitable for study of crystal structure? (2) {JUN 15 [GNE]}

2. A beam of X-rays with $\lambda = 0 \cdot 842 \text{ Å}$ is incident on a crystal at a grazing angle of $8^\circ 35'$ when first order Bragg's reflection occurs. Calculate the glancing angle for third order reflection. (4) {DEC 14 [GNE]}

3. Calculate the angle of diffraction for (110) plane of a simple cubic crystal $(d = 2 \cdot 814 \text{ Å})$ corresponding to 2^{nd} order diffraction maxima for X-rays of wavelength $0 \cdot 710 \text{ Å}$. (4) {JUN 14 [GNE]}
4. What is Bragg's law and how it is used for crystallographic studies? (3) {JUN 14 [PTU]}
5. What is X-ray diffraction? Deduce Bragg's law of X-ray diffraction in a crystal. What are Bragg's conditions for X-ray diffraction? (4) {Dec 2013 [PTU]}
6. Monochromatic X-rays of wavelength $1 \cdot 4 \text{ Å}$ are incident on a crystal having $1 \cdot 5 \text{ Å}$ interatomic spacing. Find the various orders in which the diffraction takes place. (4) {Dec 2013 [PTU]}
7. A beam of electrons is accelerated by 350V and then reflected from a crystal. The first reflection maxima occurs when the glancing angle is 30°. Determine the spacing of atomic planes the crystal. (4) {Jun 2013 [PTU]}
8. Explain Bragg's law in X-ray diffraction. Explain how it is used to find the wavelength of X-rays. (4) {Dec 2012 [GNE]}
9. If the first order beam emerged at an angle of 10° relative to the incident beam on a crystal having interplannar spacing $2 \cdot 81 \text{ Å}$, what is the wavelength of X-rays used? (4) {Dec 2012 [GNE]}
10. The first order Bragg's maxima of electron diffraction in crystal having inter atomic spacing of $0 \cdot 99 \text{ Å}$ occurs at a glancing angle of 65°. Calculate the de-Broglie wavelength of the electrons and their velocities. (4) {Dec 2012}
11. A beam of X-rays with $\lambda = 0.842 \text{ Å}$ is incident on a crystal at a grazing angle of $8^\circ 35'$ when first order Bragg's reflection occurs. Calculate the glancing angle for third order reflection. (4) {June 2012}
12. What is the significance of Bragg's Law? (2) {June 2011}
13. Why X-rays are preferred for crystal structure determination? Derive an expression for Bragg's law. How Bragg's law is used in crystallography? (5) {June 2011}
14. The first maxima for Bragg's diffraction from KCl crystal ($d = 0.314nm$) appears to be at 14°. Calculate the energy of incident X-rays. (3) {June 2010}
15. Derive Bragg's equation for diffraction of X-rays and discuss its application in X ray crystallography. (5) {May 2008}
16. State Bragg's Law. (2) {Dec 2007}
17. State and derive Bragg's Law. Write its applications in crystallography. (4) {May 2007}

18. Explain and deduce Bragg's law in X-ray diffraction. Describe Bragg's spectrometer and explain how it is used to determine the wavelength of X-rays. (6) {Dec2005}
19. A beam of X-rays is incident on a system of parallel planes, having Miller indices (0 3 4). If the wavelength of X-rays is $0 \cdot 4 \mathring{A}$ and lattice constant is $4 \mathring{A}$ (cubic system), then find the angle of diffraction for 2nd order maximum. (4) {JUN 15 [GNE]}
20. How Bravais lattice is different from simple lattice? Hence write the values of lattice parameters $(a, b, c, \alpha, \beta, \gamma)$ for any two crystal systems. (4) {JUN 15 [GNE]}
21. Discuss the shape of diamond unit cell and derive its atomic packing fraction. (5) {JUN 15 [PTU]}
22. A diffraction pattern of a cubic crystal structure of lattice parameter $3 \cdot 16 \mathring{A}$ is obtained with monochromatic X-ray beam of wavelength $1 \cdot 54 \mathring{A}$. The first line on this pattern was observed at $20 \cdot 3^{\circ}$. Determine the interplanar spacing and Miller indices of the reflecting plane. (3) {JUN 15 [PTU]}
23. What do you understand by crystallography? (2) {DEC 14 [GNE]}
24. Derive expression for separation between lattice planes for a cubic crystal system. (4) {DEC 14 [GNE]}
25. What are the essential conditions for a unit cell to be called as a primitive unit cell? (2) {DEC 14 [PTU]}
26. For an orthorhombic crystal, the lattice constants are in the ratio $a : b : c = 0 \cdot 428 : 1 : 0 \cdot 376$. Find Miller indices of the faces with intercepts $0 \cdot 214 : 1 : 0 \cdot 188$. (3) {DEC 14 [PTU]}
27. Find the Miller indices of a set of parallel planes, which makes intercepts in the ratio 3a:4b with first two crystallographic axes and parallel to the third axis. (4) {JUN 14 [GNE]}
28. What is the difference between primitive and non-primitive unit cell? (2) {JUN 14 [GNE]}
29. What do you mean by a primitive unit cell? (2) {JUN 14 [PTU]}
30. Differentiate between primitive and non primitive unit cells. (2) {Dec 2013 [GNE]}
31. A lattice plane intersects three crystallographic axes at $(-2a, 0, 0, 0)$, $(0, 5b, 0)$ and $(0, 0, 6c)$. Find Miller indices of the plane. (4) {Dec 2013 [GNE]}
32. What do you understand by crystallography? (2) {Jun 2013 [PTU]}
33. What do you mean by a primitive unit cell? (2) {Jun 2013 [GNE]}
34. Find the Miller indices for a set of planes parallel to Z axis in a cubic lattice with X and Y intercepts in the ratio 3a:4b. (3) {Jun 2013 [GNE]}
35. What do you mean by space lattice? (2) {Dec 2012}
36. What is Bravais Lattice? Discuss with suitable examples. (4) {Dec 2012}

SPECIAL THEROY OF RELATIVITY

1. What are the conditions for existence of massless particle? (2) {JUN 15 [GNE]}

2. Derive expression for Lorentz transformation equations. Under what conditions, these equations become identical with Galilean transformation. (4) {JUN 15 [GNE]}
3. A rocket is going away from earth with speed $0 \cdot 8c$. It fires a missile, which is moving with speed $0 \cdot 6c$ w.r.t. earth. Find the velocity of missile for the following cases (i) missile is going away from earth (ii) missile is going toward earth. (4) {JUN 15 [GNE]}
4. What are space like and time like intervals in relativity? (2) {JUN 15 [PTU]}
5. What is the length of a meter stick moving parallel to its length when its mass is 1.5 times its rest mass? (2) {JUN 15 [PTU]}
6. State postulates of special theory of relativity. (2) {DEC 14 [GNE]}
7. Derive expression for variation of mass of body with speed. (4) {DEC 14 [GNE]}
8. A rocket is going away from earth with speed 0.6c. It fires missile, which is moving with speed 0.8c w.r.t. earth and making an angle of 60° with the direction of motion of rocket. Find the velocity of missile w.r.t. Rocket. (4) {DEC 14 [GNE]}
9. Justify why a photon cannot be brought to rest in any frame of reference? (2) {DEC 14 [PTU]}
10. Derive expression for length contraction. (5) {DEC 14 [PTU]}
11. The mean lifetime of a muon at rest is $2 \cdot 2\mu s$. Calculate the average distance that it will travel in vacuum before decay, if it starts moving with velocity 0.9c. (3) {DEC 14 [PTU]}
12. What are postulates of Einstein's special theory of relativity? Using these, derive Lorentz transformation equations. (4) {JUN 14 [GNE]}
13. A rocket is moving away from earth with a velocity $0 \cdot 7c$. It fires a missile with velocity $0 \cdot 6c$ w.r.t. earth in its own direction. What is the velocity of the missile w.r.t. rocket? (4) {JUN 14 [GNE]}
14. Show that the speed of light in vacuum is invariant in Lorentz transformation. (2) {JUN 14 [GNE]}
15. A spaceship moving away from earth with speed 0.9c fires a missile in the same direction as its motion with speed 0.7c relative to the spaceship. What is the speed of missile relative to earth? (3) {JUN 14 [PTU]}
16. Derive Lorentz transformations equations. (5) {JUN 14 [PTU]}
17. What is the difference between inertial and non inertial frames of reference? (2) {JUN 14 [PTU]}
18. Give an account of Galilean transformation. (2) {Dec 2013 [PTU]}
19. The mass of a moving electron is 10 times its rest mass. Find its kinetic energy and momentum. (4) {Dec 2013 [PTU]}
20. Show that no signal can travel faster than light. (4) {Dec 2013 [PTU]}
21. If the total energy of a particle is twice its rest energy, then what is the velocity of the particle? (2) {Dec 2013 [PTU]}
22. A scientist observes that a certain atom 'A' moving relative to him with a velocity of $2 \times 10^{8} ms^{-1}$ emits a particle 'B', which moves with a velocity of $2 \cdot 8 \times 10^{8} ms^{-1}$ with respect to the atom 'A'. Calculate the velocity of 'B' with respect to the scientist.

23. Calculate the percentage contraction in the length of a rod moving with a velocity of $0 \cdot 8c$ in a direction inclined at 60° to its own length. (4) {Dec 2013 [PTU]}
24. Write the postulates of special theory of relativity. (2) {Dec 2013 [GNE]}
25. Two observers are moving relativistically wrt each other with uniform velocity v along X axis. How are space and time coordinates of both the observers related to each other? (4) {Dec 2013 [GNE]}
26. Two electrons are approaching each other with a aped of $0 \cdot 8c$. Find their relative speed. (4) {Dec 2013 [GNE]}
27. Define time dilation (2) {Jun 2013 [PTU]}
28. A flashing bulb is located at 40km from an observer. The bulb is fired and the observer sees the flash at $5:00\text{pm}$. What is the actual time when the bulb is fired? (4) {Jun 2013 [PTU]}
29. Develop a relation between relativistic momentum and energy. (4) {Jun 2013 [PTU]}
30. Define proper time interval and proper length interval. (2) {Jun 2013 [GNE]}
31. Using postulates of special theory of relativity deduce the formula governing the variation of mass of an object with its velocity. (4) {Jun 2013 [GNE]}
32. A spaceship moving away from the earth with a speed of $0 \cdot 9c$ fires a missile in the same direction as its motion with a speed of $0 \cdot 7c$ relative to the spaceship. What is the velocity of missile relative to earth? (4) {Jun 2013 [GNE]}
33. Rocket A travels to the right and rocket B travels to the left with velocities $0 \cdot 8c \,\&\, 0 \cdot 6c$ respectively, relative to earth. What is the velocity of rocket A with respect to rocket B? (2) {Dec 2012 [GNE]}
34. Derive an expression for Einstein's mass energy relation. (4) {Dec 2012 [GNE]}
35. What is free space? Does it exist? (2)
36. Define proper length and proper time. 92) {Dec 2012}
37. A block of metal of specific heat capacity $450 \text{Jkg}^{-1}\text{K}^{-1}$ is heated from 0°C to 90°C. Find the percentage increase in its mass. (4) {Dec 2012}
38. "No signal can travel with a velocity faster than light." Comment and justify your answer. (4) {Dec 2012}
39. What do you mean by time dilation? (2) {June 2012}
40. Elaborate the concept and utility of Lorentz transformation. (5) {June 2012}
41. Give Einstein's postulates of special theory of relativity. (2) {Dec 2011}
42. A particle of rest mass m_0 moves with speed $\frac{c}{2}$. Calculate its mass, momentum, total energy and kinetic energy. (3) {Dec 2011}
43. Explain the Einstein's concept of time dilation. Deduce the necessary relation. (5) {Dec 2011}
44. Does photon have mass? If no, then how photons have momentum? (2) {June 2011}
45. Calculate the mass and velocity of an electron having a total energy of 2MeV. (3) {June 2011}
46. State the fundamental postulates of special theory of relativity and hence deduce the Lorentz transformation. (5) {June 2011}

47. A stationary body explodes into two fragments, each of rest mass 1kg, that move apart at speeds of $0 \cdot 6c$ relative to the original body. Find the mass of original body. (2) {Dec 2010}
48. Show that the rest mass of a particle is given by $m_0 = \frac{p^2c^2 - T^2}{2Tc^2}$; where p and T denote the momentum and kinetic energy of the particle respectively. (3) {Dec 2010}
49. Two photons approach each other. What is their relative velocity? (2) {Dec 2010}
50. How do you define proper length and proper time as per special theory of relativity? (2) {June 2010}
51. State and explain the postulates of special theory of relativity with the help of an example. (2) {June 2010}
52. Define time dilation and derive expression relating time interval as observed in two different inertial frames of reference. (3) {June 2010}
53. Find the total energy of an electron and a proton, both having momentum equal to $2MeV/c$. (3) {June 2010}
54. Explain the term time dilation. (2) {Dec 2009}
55. Explain various postulates of special theory of relativity. (3) {Dec 2009}
56. Explain the term Length contraction. (2) {June 2009}
57. Differentiate between inertial and non inertial frames of reference. (2) {June 2009}
58. Derive expression for Lorentz Transformation equations. (5) {June 2009}
59. Prove that the velocity of light is independent of the velocity of the frame of reference. (3) {June 2009}
60. Derive Lorentz transformation equations and apply them to explain (i) Length contraction (ii) time dilation. (4+2+2) {Dec 2008}
61. Explain why a particle cannot move faster than speed of light? (2) {May 2008}
62. Write postulates of Einstein's special theory relativity. (2) {Dec 2007}
63. Show that the relativistic form of Newton's second law, when F is parallel to v is $F = m_0 \frac{\mathrm{dv}}{\mathrm{dt}}\left(1 - \frac{\mathrm{v}^2}{c^2}\right)^{-\frac{3}{2}}$. (4) {Dec 2007}
64. Write Lorentz transformations. (2) {May 2007}
65. If T is the relativistic kinetic energy of a particle of mass m_0, then show that $T^2 + 2m_0c^2T = p^2c^2$. (4) {May 2007}
66. A particle of mass M disintegrates while at rest into two parts having masses $\frac{M}{2}$ & $\frac{M}{4}$. Show that the relativistic kinetic energies of the parts are $\frac{3Mc^2}{32}$ & $\frac{5Mc^2}{32}$ respectively. (4) {May 2007}
67. An event occurs in the frame S at $t = 1ms$ at $x = 5km$. The position of the point of occurrence of event in frame S' appears to be $x' = 35km$. Find the time of occurrence of the event (t') in the frame S'. (2) {Dec 2006}

68. Show that the law of addition of velocity predicts the constant value of the velocity of light in all the inertial frames. (2) {Dec 2006}
69. Explain the postulates of special theory of relativity and derive the Lorentz transformation equations. (5) {Dec 2006}
70. Two particles come towards each other with speed $0 \cdot 8c$ with respect to the laboratory. What is their relative speed? (3) {Dec 2006}
71. Show that relativistic law of addition of velocities predicts constant value of velocity of light in all inertial frames. (2) {Dec2005}
72. Explain the postulates of theory of relativity and derive Lorentz transformation equation. (5) {Dec2005}
73. A certain process requires $10^{-6} s$ to occur in an atom at rest in the laboratory. How much time will this process require to an observer in the laboratory, when the atom is moving with a speed of $5 \times 10^{7} ms^{-1}$? (3) {Dec2005}
74. State Einstein's postulates of special theory of relativity. (2) {May 2005}
75. On the basis of Lorentz transformation, discuss the following kinematic effects: (i) length contraction (ii) time dilation (4) {May 2005}
76. A scientist observes that a certain atom A moving with respect to him with a velocity of $2 \times 10^{10} cms^{-1}$ emits a particle B, which is moving with velocity $2 \cdot 8 \times 10^{10} cms^{-1}$ with respect to the atom. Calculate the relative velocity of the emitted particle with respect to the scientist. (4) {May 2005}
77. State Einstein's postulates of special theory of relativity. (2) {Dec 2004}
78. Show that the mass of a body in motion is given by: $m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}}$, where m_0 is the rest mass of the body and m is the mass when it is moving with speed v. (8)
79. Define inertial frame of reference. Does an inertial frame of reference exist? (2) {May 2004}
80. Derive expression for variation of mass of a body with speed. (5) {May 2004}
81. Define Proper length and Proper time. A space crew has a life support system that will last for 1000hours. Find the minimum speed for safe travel between two space stations at a proper distance of $8 \times 10^{11} km$ from each other. (3)
82. State postulates of special theory of relativity. (2) {Dec 2003}