

PHYSICS

1. A boy sitting on the top most berth in the compartment of a train which is just going to stop on a railway station, drops an apple aiming at the open hand of his brother sitting vertically below at a distance of about two meters. The apple will fall :
 - (a) precisely on the hand of his brother
 - (b) slightly away from the hand of his brother in the direction of motion of the train
 - (c) slightly away from the hand of his brother in the direction opposite to the direction of motion of the train
 - (d) none of (a) to (c)
2. A body of mass m is rotated in a vertical circle of radius r . The minimum velocity of the body at the top most position for the string to remain just stretched is :
 - (a) $\sqrt{2gr}$
 - (b) \sqrt{gr}
 - (c) $\sqrt{3gr}$
 - (d) $\sqrt{4gr}$
3. Two particles of masses m_1 and m_2 ($m_1 > m_2$) attract each other with a force inversely proportional to the square of the distance between them. The particles are initially at rest and then released. Which of the following statements is correct ?
 - (a) Centre of mass (CM) moves towards m_1
 - (b) CM moves towards m_2
 - (c) CM remains at rest
 - (d) CM moves at right angles to the line joining m_1 and m_2
4. A metal ball hits a wall and does not rebound whereas a rubber ball of the same mass on hitting the wall with the same velocity rebounds back. It can be concluded that :
 - (a) metal ball suffers greater change in momentum
 - (b) rubber ball suffers greater change in momentum
 - (c) the initial momentum of metal ball is greater than initial momentum of rubber ball
 - (d) both suffer same change in momentum
5. In which case does the potential energy decrease ?
 - (a) on compressing a spring
 - (b) on stretching a spring
 - (c) on moving a body against the gravitational force
 - (d) on the rising of an air bubble in water

6. Two simple harmonic motions act on a particle. These harmonic motions are : $x = A \cos (\omega t + \delta)$ and $y = A \cos (\omega t + \alpha)$, where $\delta = \alpha + \pi/2$. The resulting motion is :
- a circle and actual motion is counter clockwise
 - a circle and actual motion is clockwise
 - an ellipse and actual motion is counter clockwise
 - an ellipse and actual motion is clockwise
7. According to the Hooke's law of elasticity, if stress is increased, the ratio of stress to strain :
- increases
 - decreases
 - becomes zero
 - remains constant
8. A piece of ice is floating in a jar containing water. When the ice melts, then the level of water :
- rises
 - falls
 - remains unchanged
 - rises or falls depending on the mass of ice
9. $\nabla \times (\phi \nabla \phi)$, where ϕ is a scalar function, is equal to :
- zero
 - $\nabla^2 \phi$
 - $\phi \nabla^2$
 - $\nabla^2 \phi^2$
10. Which of the following statements is *not* correct ?
- Curl of a gradient is always zero
 - Divergence of curl is always zero
 - Divergence of gradient is always zero
 - Vector product of two identical vectors is always zero

11. The total electric flux, leaving a spherical surface of radius one cm and surrounding an electric dipole is :
- q/ϵ_0
 - zero
 - $2q/\epsilon_0$
 - $8\pi r^2 q/\epsilon_0$
12. How does the electric field strength vary when we enter a uniformly charged spherical cloud ?
- decreases inversely as the square of the distance from the surface
 - decreases directly as the square of the distance from the surface
 - decreases directly as the square of the distance from the centre
 - decreases directly as the distance from the centre
13. A parallel plate capacitor with air as dielectric is charged to a potential V . It is then connected to an uncharged parallel plate capacitor filled with wax of dielectric constant K . The common potential of both capacitors is :
- V
 - KV
 - $(1 + K)V$
 - $V/(1 + K)$
14. Which of the following statements is *correct* when comparing electric field $\left(\vec{E}\right)$ and electric displacement $\left(\vec{D}\right)$?
- both \vec{E} and \vec{D} satisfy Coulomb's law
 - \vec{E} satisfies Coulomb's law and not \vec{D}
 - \vec{E} satisfies Gauss law and not \vec{D}
 - \vec{D} satisfies Gauss law and not \vec{E}
15. A uniform resistance wire of length l and diameter d has a resistance R . Another wire of same material has length $4l$ and diameter $2d$, the resistance will be :
- $2R$
 - R
 - $R/2$
 - $R/4$

16. An electron moves with some velocity along x -direction. If a magnetic field acts along y -direction, the force on the electron acts in :
- x -direction
 - y -direction
 - z -direction
 - arbitrary direction
17. A charged particle moving with velocity v is subjected to electric field E and magnetic field B . The particle will go undeflected if :
- E , B and v are mutually perpendicular and $v = E/B$
 - E is perpendicular to B
 - E is parallel to v and perpendicular to B
 - E and B both are parallel to v
18. Which of the following statements is correct ?
- both electric and magnetic dipole moments depend on the choice of the origin
 - electric dipole is always independent of the choice of the origin
 - electric dipole is independent of the choice of the origin only when total charge vanishes
 - magnetic dipole depends on the choice of the origin
19. What is the origin of Maxwell's equations ?
- classical mechanics
 - quantum mechanics
 - theory of relativity
 - experimental facts
20. For a plane monochromatic electromagnetic wave, which of the following equation demonstrates that electric and magnetic fields are perpendicular to each other :
- $\nabla \cdot \vec{E} = 0$
 - $\nabla \cdot \vec{E} = -\partial \vec{B} / \partial t$
 - $\nabla \cdot \vec{B} = 0$
 - none of (a) to (c)

21. Consider a macroscopic particle of mass m immersed in a liquid at temperature T . Let z -axis point in the direction of the gravitational field. The mean value of the x -component of the velocity (v_x) vanishes by symmetry. The fluctuation of v_x (v_x^2) is equal to :
- (a) kT/m
 - (b) zero
 - (c) kT
 - (d) $kT/2$
22. Which of the following statement is *not* correct regarding the specific heat of a gas ?
- (a) classical theory shows that specific heat is always equal to $3R$ independent of the temperature
 - (b) Einstein's theory predicts that at high temperatures specific heat is equal to $3R$
 - (c) Einstein's theory predicts that at low temperatures specific heat is equal to $3R$
 - (d) experimental data shows that specific heat at low temperatures is proportional to T^2
23. van der Waals equation can be obtained by considering that :
- (a) all the molecules move independent of each other
 - (b) each molecule interacts with an average potential generated by other molecules
 - (c) only pairwise interaction among the molecules
 - (d) gas is very dilute
24. In a mechanical refrigerator, the low temperature coils of the evaporator are at -23°C and the compressed gas in the condenser has a temperature of 77°C . The coefficient of performance is :
- (a) 70%
 - (b) 20%
 - (c) 0.23
 - (d) 2.5
25. We consider a thermodynamic system. If ΔU represents the increase in its internal energy and W the work done by the system, which of the following statements is *true* ?
- (a) $\Delta U = -W$ is an adiabatic process
 - (b) $\Delta U = W$ is an adiabatic process
 - (c) $\Delta U = -W$ is an isothermal process
 - (d) $\Delta U = W$ is an isothermal process

26. Absolute temperature below 1°K are measured using :
- (a) ordinary thermometer
 - (b) first law of thermodynamics and known temperature dependence of a macroscopic quantity
 - (c) second law of thermodynamics and known temperature dependence of a macroscopic quantity
 - (d) Curie's law
27. A critical point is :
- (a) where liquid-gas equilibrium line ends
 - (b) volume changes between liquid and gas approaches zero
 - (c) beyond which no further phase transformation is possible
 - (d) all of (a) to (c)
28. A system of dipoles has maximum statistical weight when :
- (a) all the dipoles are aligned parallel to the external magnetic field
 - (b) all the dipoles are aligned anti-parallel to the external magnetic field
 - (c) half of the dipoles are parallel and half anti-parallel to the external magnetic field
 - (d) none of (a) to (c)
29. The reason that Maxwellian distribution of speeds has Gaussian shape is :
- (a) the molecules considered are non-interacting
 - (b) translational motion of the centre of mass is only considered
 - (c) Boltzmann probability is considered in the derivation
 - (d) all of (a) to (c)
30. A Fermi system is in the ground state if :
- (a) all the states below the Fermi level are occupied at zero temperature
 - (b) all the states below the Fermi level are occupied at room temperature
 - (c) one of the states above the Fermi level is occupied
 - (d) all the states above the Fermi level are occupied

31. In a sinusoidal wave, the time required for a particular point to move from maximum displacement to zero displacement is 0.17 sec. The frequency of the wave is :
- (a) 2.94 Hz
 - (b) 1.47 Hz
 - (c) 0.36 Hz
 - (d) 0.73 Hz
32. A wave represented by equation $y = a \cos(kx - \omega t)$ is superposed with another wave to form a stationary wave such that point $x = 0$ is a node. The equation for the other wave is :
- (a) $a \sin(kx + \omega t)$
 - (b) $-a \cos(kx + \omega t)$
 - (c) $-a \cos(kx - \omega t)$
 - (d) $-a \sin(kx - \omega t)$
33. When we hear a sound, we can identify its source from :
- (a) amplitude of sound
 - (b) intensity of sound
 - (c) wavelength of sound
 - (d) overtones present in the sound
34. Inner walls of big halls should be good sound :
- (a) amplifier
 - (b) reflector
 - (c) absorber
 - (d) transmitter
35. An achromatic convergent lens of focal length +20 cm is made of two lenses (in contact) of materials having dispersive powers in the ratio of 1 : 2 and having focal lengths f_1 and f_2 , which of the following is true ?
- (a) $f_1 = 10$ cm, $f_2 = -20$ cm
 - (b) $f_1 = 20$ cm, $f_2 = 10$ cm
 - (c) $f_1 = -10$ cm, $f_2 = -20$ cm
 - (d) $f_1 = 20$ cm, $f_2 = -10$ cm

36. In Ramsden's eyepiece, the field lens and eye lens have focal lengths f_1 and f_2 respectively and separated by distance d then :
- (a) $f_1 = (2/3)f_2; d = (2/3)f_1$
 - (b) $f_1 = f_2; d = f_1 + f_2$
 - (c) $f_1 = f_2; d = (2/3)f_1$
 - (d) $f_1 = 3f_2; f_1 + f_2$
37. In Young's double slit experiment, we get 60 fringes in the field of view of monochromatic light of wavelength 4000 \AA . If we use monochromatic light of wavelength 6000 \AA , then the number of fringes obtained in the same field of view is :
- (a) 90
 - (b) 40
 - (c) 60
 - (d) 1.5
38. The condition for observing Fraunhofer diffraction from a single slit is that the light wavefront incident on the slit should be :
- (a) spherical
 - (b) cylindrical
 - (c) elliptical
 - (d) plane
39. To observe diffraction, the size of an obstacle :
- (a) should be of the same order as wavelength
 - (b) should be much larger than the wavelength
 - (c) have no relation to wavelength
 - (d) should be exactly half of the wavelength
40. Electromagnetic waves are transverse in nature is evident from :
- (a) interference
 - (b) diffraction
 - (c) polarization
 - (d) reflection

41. The apparent length of a meter stick measured by an observer at rest when the stick is moving along its length with a velocity equal to c :
- zero
 - infinite
 - one meter
 - none of (a) to (c)
42. The kinetic energy of a particle moving with relativistic speed v is given by (m_0 is the rest mass) :
- $\frac{1}{2}m_0v^2$
 - $\frac{1}{2} \frac{m_0v^2}{\sqrt{1-v^2/c^2}}$
 - $\frac{m_0c^2}{\sqrt{1-v^2/c^2}}$
 - $\left(\frac{m_0}{\sqrt{1-v^2/c^2}} - m_0 \right) c^2$
43. An electron and proton have the same de-Broglie wavelength. Then the kinetic energy of the electron is :
- zero
 - greater than the kinetic energy of the proton
 - less than the kinetic energy of the proton
 - equal to the kinetic energy of the proton
44. When yellow light is incident on a surface no electrons are emitted, while green light can emit. If red light is incident on the surface :
- no electrons will be emitted
 - photons are emitted
 - electrons of higher energy are emitted
 - electrons of lower energy are emitted
45. For particle in a one-dimensional box, the probability of finding the particle, which is in the first excited state $n = 2$, is :
- same throughout the box
 - zero throughout the box
 - minimum in the middle
 - maximum in the middle

46. The speed of an electron in the orbit of hydrogen atom in the ground state is :
- (a) c
 - (b) $c/10$
 - (c) $c/2$
 - (d) $c/137$
47. Discrete X-ray spectrum is obtained from :
- (a) transitions of the electrons from inner most orbits
 - (b) transitions of the electrons from outer most orbits
 - (c) molecular vibrations
 - (d) nuclear rotations
48. Molecular rotation is possible for :
- (a) non-polar molecules
 - (b) polar molecule
 - (c) H_2 molecule
 - (d) all molecules
49. The binding energy per nucleon is maximum for :
- (a) He^4
 - (b) Ba^{141}
 - (c) Fe^{56}
 - (d) U^{235}
50. The range of nuclear force is about :
- (a) 2×10^{-10} m
 - (b) 1.5×10^{-20} m
 - (c) 7.2×10^{-4} m
 - (d) 1.4×10^{-15} m

51. Which of the following is *not* the property of a crystalline substance ?
- (a) isotropic electrical conductivity
 - (b) long range order
 - (c) flat surface
 - (d) sharp melting point
52. The three axes of a crystal lattice are mutually perpendicular and two of the lattice parameters are equal. The crystal system is :
- (a) cubic
 - (b) tetragonal
 - (c) orthorhombic
 - (d) hexagonal
53. The properties of phonons are determined from inelastic scattering of :
- (a) gamma rays
 - (b) α -particles
 - (c) X-rays
 - (d) electrons
54. The paramagnetic contribution to magnetization originates from :
- (a) only spin of the electron
 - (b) only orbital motion of the electron
 - (c) both spin and orbital motion of the electron
 - (d) change in orbital moment induced by an applied magnetic field
55. Energy bands in solids is a consequence of :
- (a) Ohm's law
 - (b) Bohr's theory
 - (c) Heisenberg's uncertainty principle
 - (d) Pauli's exclusion principle

56. At zero kelvin, a piece of Germanium :
- (a) becomes a semiconductor
 - (b) becomes good conductor
 - (c) becomes bad conductor
 - (d) has maximum conductivity
57. When N-P-N transistor is used in an amplifier, then :
- (a) holes move from emitter to base
 - (b) electrons move from base to collector
 - (c) holes move from base to emitter
 - (d) electrons move from collector to base
58. The cause of potential barrier in a P-N junction is :
- (a) depletion of positive charges near the junction
 - (b) concentration of positive charges near the junction
 - (c) depletion of negative charges near the junction
 - (d) concentration of positive and negative charges near the junction
59. A transistor is preferable to a triode valve because it :
- (a) does not require a heater
 - (b) can withstand large changes in temperature
 - (c) has high input impedance
 - (d) can handle large power
60. In N-P-N transistor circuit, the collector current is 10 mA. If 90% of the electrons emitted reach the collector :
- (a) the emitter current will be 9 mA
 - (b) the emitter current will be 11 mA
 - (c) the emitter current will be 1 mA
 - (d) the emitter current will be 0.1 mA