Physics

Question 1.
A proton, an electron, and an alpha particle have the same energies. Their de-Broglie wavelengths will be compared as:

1. $\lambda_e > \lambda_\alpha > \lambda_p$
2. $\lambda_\alpha < \lambda_p < \lambda_e$
3. $\lambda_p < \lambda_e < \lambda_\alpha$
4. $\lambda_p > \lambda_e > \lambda_\alpha$

Question 2.
A particle moving in a straight line covers half the distance with speed $6\,\text{m/s}$. The other half is covered in two equal time intervals with speeds $9\,\text{m/s}$ and $15\,\text{m/s}$, respectively. The average speed of the particle during the motion is:

1. $8.8\,\text{m/s}$
2. $10\,\text{m/s}$
3. $9.2\,\text{m/s}$
4. $8\,\text{m/s}$

Question 3.
A plane EM wave is propagating along the x-direction. It has a wavelength of $4\,\text{mm}$. If the electric field is in the y-direction with the maximum magnitude of $60\,\text{Vm}^{-1}$, the equation for the magnetic field is:

1. $B_z = 60 \sin\left[\frac{\pi}{2}\left(x - 3 \times 10^8 t\right)\right]\,\hat{k}\,\text{T}$
2. $B_z = 2 \times 10^{-7} \sin\left[\frac{\pi}{2} \times 10^3\left(x - 3 \times 10^8 t\right)\right]\,\hat{k}\,\text{T}$
3. $B_x = 60 \sin\left[\frac{\pi}{2}\left(x - 3 \times 10^8 t\right)\right]\,\hat{i}\,\text{T}$
4. $B_z = 2 \times 10^{-7} \sin\left[\frac{\pi}{2}\left(x - 3 \times 10^8 t\right)\right]\,\hat{k}\,\text{T}$

Question 4.
Given below are two statements: **Statement (I):** When an object is placed at the centre of curvature of a concave lens, the image is formed at the centre of curvature of the lens on the other side.
Statement (II): Concave lens always forms a virtual and erect image.
In the light of the above statements, choose the correct answer from the options given below:

1. Statement I is false but Statement II is true.

2. Both Statement I and Statement II are false.
3. Statement I is true but Statement II is false.
4. Both Statement I and Statement II are true.

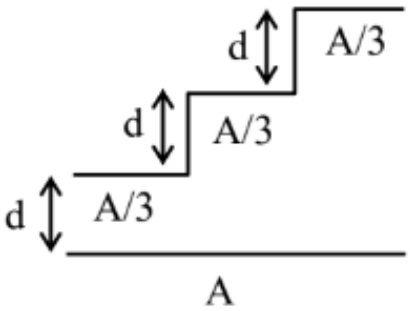
Question 5.
A light-emitting diode (LED) is fabricated using GaAs semiconducting material whose band gap is 1.42 eV. The wavelength of light emitted from the LED is:

1. 650 nm
2. 1243 nm
3. 875 nm
4. 1400 nm

Question 6.
A sphere of relative density σ and diameter D has a concentric cavity of diameter d. The ratio of $\frac{D}{d}$, if it just floats on water in a tank, is:

1. $\left(\frac{\sigma}{\sigma-1}\right)^{\frac{1}{3}}$
2. $\left(\frac{\sigma+1}{\sigma-1}\right)^{\frac{1}{3}}$
3. $\left(\frac{\sigma-1}{\sigma}\right)^{\frac{1}{3}}$
4. $\left(\frac{\sigma-2}{\sigma+2}\right)^{\frac{1}{3}}$

Question 7.
A capacitor is made of a flat plate of area A and a second plate having a stair-like structure as shown in the figure. If the area of each stair is $\frac{A}{3}$ and the height is d, the capacitance of the arrangement is:



1. $\frac{11\epsilon_0 A}{18d}$
2. $\frac{13\epsilon_0 A}{17d}$

3. $\frac{11\epsilon_0 A}{20d}$
4. $\frac{18\epsilon_0 A}{11d}$

Question 8.
A light, unstretchable string passing over a smooth light pulley connects two blocks of masses m_1 and m_2. If the acceleration of the system is $\frac{g}{8}$, then the ratio of the masses $\frac{m_2}{m_1}$ is:

1. $9:7$
2. $4:3$
3. $5:3$
4. $8:1$

Question 9.
The dimensional formula of latent heat is:

1. $[M^0LT^{-2}]$
2. $[MLT^{-2}]$
3. $[M^0L^2T^{-2}]$
4. $[ML^2T^2]$

Question 10.
The volume of an ideal gas ($\gamma = 1.5$) is changed adiabatically from 5 litres to 4 litres. The ratio of initial pressure to final pressure is:

1. $\frac{4}{5}$
2. $\frac{16}{25}$
3. $\frac{8}{5\sqrt{5}}$
4. $\frac{2}{\sqrt{5}}$

Question 11.
The energy equivalent of 1 g of substance is:

1. 11.2×10^{24} MeV
2. 5.6×10^{12} MeV
3. 5.6 eV
4. 5.6×10^{26} MeV

Question 12.
An astronaut takes a ball of mass m from Earth to space. He throws the ball into a circular orbit about Earth at an altitude of $318.5\,\text{km}$. From Earth's surface to the orbit, the change in total mechanical energy of the ball is $x\frac{GM_em}{21R_e}$. The value of x is:

1. 11
2. 9
3. 12
4. 10

Question 13.
Given below are two statements:

- **Statement I:** When currents vary with time, Newton's third law is valid only if momentum carried by the electromagnetic field is taken into account.
- **Statement II:** Ampere's circuital law does not depend on Biot-Savart's law.

In the light of the above statements, choose the correct answer from the options given below:

1. Both Statement I and Statement II are false.
2. Statement I is true but Statement II is false.
3. Statement I is false but Statement II is true.
4. Both Statement I and Statement II are true.

Question 14.
A particle of mass m moves on a straight line with its velocity increasing with distance according to the equation $v = \alpha\sqrt{x}$, where α is a constant. The total work done by all the forces applied on the particle during its displacement from $x = 0$ to $x = d$, will be:

1. $\frac{m}{2\alpha^2 d}$
2. $\frac{md}{2\alpha^2}$
3. $\frac{m\alpha^2 d}{2}$
4. $2m\alpha^2 d$

Question 15.
A galvanometer has a coil of resistance $200\,\Omega$ with a full-scale deflection at $20\,\mu\text{A}$. The value of resistance to be added to use it as an ammeter of range $0-20\,\text{mA}$ is:

1. $0.40\,\Omega$
2. $0.20\,\Omega$
3. $0.50\,\Omega$
4. $0.10\,\Omega$

Question 16.
A heavy iron bar, of weight W, is having its one end on the ground and the other on the shoulder of a person. The bar makes an angle θ with the horizontal. The weight experienced by the person is:

1. $\frac{W}{2}$
2. W
3. $W\cos\theta$
4. $W\sin\theta$

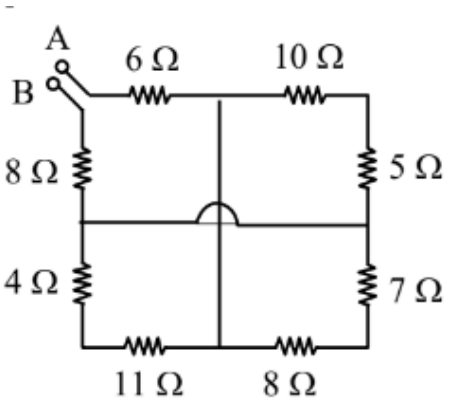
Question 17.
One main scale division of a vernier caliper is equal to m units. If n^{th} division of the main scale coincides with $(n+1)^{th}$ division of the vernier scale, the least count of the vernier caliper is:

1. $\frac{n}{n+1}$
2. $\frac{m}{n+1}$
3. $\frac{1}{n+1}$
4. $\frac{m}{n(n+1)}$

Question 18.
A bulb and a capacitor are connected in series across an AC supply. A dielectric is then placed between the plates of the capacitor. The glow of the bulb:

1. increases
2. remains same
3. becomes zero
4. decreases

Question 19.
The equivalent resistance between A and B is:



1. $18\,\Omega$
2. $25\,\Omega$
3. $27\,\Omega$
4. $19\,\Omega$

Question 21.
If $\vec{a}$ and $\vec{b}$ make an angle $\cos^{-1}\left(\frac{5}{9}\right)$ with each other, then $|\vec{a}+\vec{b}| = \sqrt{2}|\vec{a}-\vec{b}|$ for $|\vec{a}| = n|\vec{b}|$. The integer value of n is:

Question 22. At the centre of a half-ring of radius $R = 10\,\text{cm}$ and linear charge density $4\,\text{nC/m}$, the potential is $x\pi V$. The value of x is _____.

Question 23.
A star has 100% helium composition. It starts to convert three ^{4}He into ^{12}C via the triple alpha process as:

$$^4\text{He} + ^4\text{He} + ^4\text{He} \rightarrow ^{12}\text{C} + Q.$$

The mass of the star is 2.0×10^{32} kg and it generates energy at the rate of 5.808×10^{30} W. The rate of converting these ^{4}He to ^{12}C is $n \times 10^{42}\ \text{s}^{-1}$, where n is ..... [Take, mass of $^4\text{He} = 4.0026$ u, mass of $^{12}\text{C} = 12$ u].

Question 24.
In a Young's double-slit experiment, the intensity at a point is $\frac{1}{4}$ of the maximum intensity. The minimum distance of the point from the central maximum is ..... μm. (Given: $\lambda = 600\,\text{nm}$, $d = 1.0\,\text{mm}$, $D = 1.0\,\text{m}$)

Question 25.
A string is wrapped around the rim of a wheel of moment of inertia $0.40\,\text{kgm}^2$ and radius $10\,\text{cm}$. The wheel is free to rotate about its axis. Initially, the wheel is at rest. The string is now pulled by a force of $40\,\text{N}$. The angular velocity of the wheel after $10\,\text{s}$ is x rad/s, where x is .....

Question 26.
A square loop of edge length 2 m carrying a current of 2 A is placed with its edges parallel to the x-y-axis. A magnetic field is passing through the x-y-plane and is expressed as:

$$\vec{B} = B_0(1 + 4x)\hat{k},$$

where $B_0 = 5$ T. The net magnetic force experienced by the loop is ..... N.

Question 27.
Two persons pull a wire towards themselves. Each person exerts a force of 200 N on the wire. The Young's modulus of the material of the wire is 1×10^{11} N/m^2. The original length of the wire is 2 m, and the area of the cross-section is 2 cm^2. The wire will extend in length by ..... μm.

Question 28.
When a coil is connected across a 20 V DC supply, it draws a current of 5 A. When it is connected across a 20 V, 50 Hz AC supply, it draws a current of 4 A. The self-inductance of the coil is ..... mH. ($\pi = 3$)

Question 29.
The position, velocity, and acceleration of a particle executing simple harmonic motion are found to have magnitudes of 4 m, 2 ms^{-1}, and 16 ms^{-2} at a certain instant. The amplitude of the motion is $\sqrt{x}$ m, where x is .....

Question 30.
The current flowing through the $1\,\Omega$ resistor is $\frac{n}{10}$. The value of n is .....