JEE-MAIN EXAM APRIL, 2024

Date: - 09-04-2024 (SHIFT-1)

PHYSICS

SECTION-A

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) $\lambda_p > \lambda_e > \lambda_\alpha$

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

(1) 8.8 m/s (2) 10 m/s (3) 9.2 m/s (4) 8 m/s

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

(1) $B_z = 60\sin\left[\frac{\pi}{2}\left(x-3\times10^9 t\right)\right]\hat{k}T$ (2) $B_z = 2\times10^{-5}\sin\left[\frac{\pi}{2}\times10^3\left(x-3\times10^8 t\right)\right]\hat{k}T$

(3) $B_x = 60\sin\left[\frac{\pi}{2}\left(x-3\times10^9 t\right)\right]\hat{i},T$ (4) $B_z = 2\times10^{-7}\sin\left[\frac{\pi}{2}\left(x-3\times10^8 t\right)\right]\hat{k}T$

4. Given below are two statements:

Statement (I): When an object is placed at the centre of curvature of a concave lens, 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.

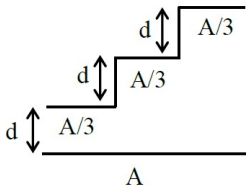
5. A light emitting diode (LED) is fabricated using GaAs semiconducting material whose band gap is 1.42 eV. The wavelength of light emitted from the LED is:

(1) 650 nm (2) 1243 nm (3) 875 nm (4) 1400 nm

6. A sphere of relative density σ and diameter D has 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) $\left(\frac{\sigma-2}{\sigma+2}\right)^{\frac{1}{3}}$

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



(1) $\frac{11\varepsilon_0 A}{18d}$ (2) $\frac{13\varepsilon_0 A}{17d}$ (3) $\frac{11\varepsilon_0 A}{20d}$ (4) $\frac{18\varepsilon_0 A}{11d}$

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

9. The dimensional formula of latent heat is:

(1) $\left[M^0LT^{-2}\right]$ (2) $\left[MLT^{-2}\right]$ (3) $\left[M^0L^2T^{-2}\right]$ (4) $\left[ML^2T^{-2}\right]$

10. The volume of an ideal gas (γ = 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) $\frac{2}{\sqrt{5}}$

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

(1) $11.2\times10^{24}\,MeV$ (2) $5.6\times10^{12}\,MeV$

(3) 5.6 eV (4) $5.6\times10^{26}\,MeV$

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 km. From earth's surface to the orbit, the change in total mechanical energy of the ball is $x\frac{G_e m}{21R_e}$. The value of x is (take R_e = 6370 km):

(1) 11 (2) 9 (3) 12 (4) 10

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.

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) $2m\alpha^2 d$

15. A galvanmeter has a coil of resistance 200Ω with a full scale deflection at 20 μA. The value of resistance to be added to use it as an ammeter of range (0–20) mA is:

(1) 0.40Ω (2) 0.20Ω (3) 0.50Ω (4) 0.10Ω

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) Wcosθ (4) Wsinθ

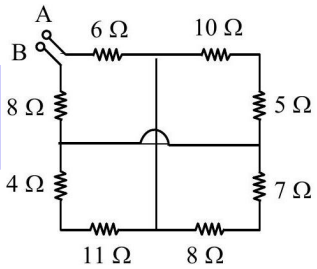
17. One main scale division of a vernier caliper is equal to m units. If n^{th} division of main scale coincides with $(n + 1)^{th}$ division of vernier scale, the least count of the vernier caliper is:

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

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

19. The equivalent resistance between A and B is:



(1) 18 Ω (2) 25 Ω (3) 27 Ω (4) 19 Ω

20. A sample of 1 mole gas at temperature T is adiabatically expanded to double its volume. If adiabatic constant for the gas is $\gamma = \frac{3}{2}$, then the work done by the gas in the process is:

(1) $RT[2-\sqrt{2}]$ (2) $\frac{R}{T}[2-\sqrt{2}]$ (3) $RT[2+\sqrt{2}]$ (4) $\frac{T}{R}[2+\sqrt{2}]$

SECTION-B

21. If $\vec{a}$ and $\vec{b}$ makes 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

22. At the centre of a half ring of radius R = 10 cm and linear charge density 4ncm^{-1}, the potential is xπV. The value of x is

23. A star has 100% helium composition. It starts to convert three ^{4}He into one ^{12}C via triple alpha process as $^4He + ^4He + ^4He \rightarrow ^{12}C + Q$. 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 × 10^{42} s^{-1}, where n is [Take, mass of ^{4}He = 4.0026 u, mass of ^{12}C = 12u]

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

25. A string is wrapped around the rim of a wheel of moment of inertia 0.40 kgm^2 and radius 10 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 N. The angular velocity of the wheel after 10 s is xrad/s, where x is

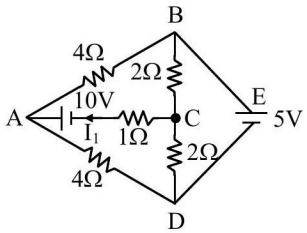
26. A square loop of edge length 2 m carrying current of 2A is placed with its edges parallel to the x – y axis. A magnetic field is passing through the x – y plane and expressed as $\vec{B} = B_0(1+4x)\hat{k}$, where B$_0$ = 5 T. The net magnetic force experienced by the loop is N.

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

28. When a coil is connected across a 20 V dc supply, it draws a current of 5 A. When it is connected across 50 V, 50 Hz ac supply, it draws a current of 4 A. The self inductance of the coil is mH. (Take π = 3)

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

30. The current flowing through the 1Ω resistor is $\frac{n}{10}$ A. The value of n is



NTA ANSWERS

1.	(2)	2.	(4)	3.	(2)	4.	(1)	5.	(3)	6.	(1)	7.	(1)
8.	(1)	9.	(3)	10.	(3)	11.	(4)	12.	(1)	13.	(2)	14.	(3)
15.	(2)	16.	(1)	17.	(2)	18.	(1)	19.	(4)	20.	(1)	21.	(3)
22.	(36)	23.	(5)	24.	(200)	25.	(100)	26.	(160)	27.	(20)	28.	(10)
29.	(17)	30.	(25)										