UGC POINT

LEADING INSTITUE FOR CSIR-JRF/NET,GATE & JAM

BOOKLET CODE
B

SUBJECT CODE
05

PHYSICAL SCIENCE

TEST SEREIS # 2

E.M.T., NUCLEAR & PARTICLE PHYSICS

Date: 25/5/2015
Maximum Marks: 80

Timing: 2:00 H

Instructions

1. This test paper has a total of 40 questions carrying 80 marks. All Question are compulsory
2. Read the Questions carefully and mark your appropriate response to the OMR sheet
3. There is Negative marking of 1/4 for Each wrong answer
4. Mark the response by **Black** or **Blue** Ball Pen only
5. Any other belongings like Book/ Notes / Electronic device etc are not permitted in the examination hall.
6. Submit your answer sheet (OMR Sheet) to the invigilator before leaving the examination hall

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1. A solid sphere of radius R has a charge density given by

$$\rho(r) = \rho_0\left(1 - \frac{r}{R}\right)$$

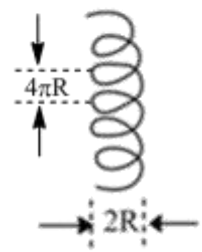
Where r is the radial coordinate and ρ_0 and R are positive constants. If the magnitude of electric field at $r = R$ is E_0 then the electric field at $r = \frac{R}{2}$ is

(1) $\frac{E_0}{2}$ (2) $\frac{3E_0}{4}$ (3) $\frac{5E_0}{4}$ (4) $\frac{3E_0}{2}$

2. A charged particle moves in a helical path under the influence of a constant magnetic field. The radius of helical path is R and the pitch of the path is $4\pi R$. If the component of velocity along magnetic field is υ then the component of the velocity in plane perpendicular to the magnetic field is

(1) $\frac{\upsilon}{4}$ (2) $\frac{\upsilon}{2}$

(3) υ (4) 2υ



3. The space time dependence of the electric field of a linearly polarized light in free space is given by $\hat{x}E_0\cos(\omega t - kz)$ where E_0, ω & k are the amplitude, the angular frequency and the wave vector respectively. The time average energy density of the wave is

(1) $\frac{1}{2}\varepsilon_0 E_0^2$ (2) $\varepsilon_0 E_0^2$ (3) $\frac{\varepsilon_0 E_0^2}{4}$ (4) $2\varepsilon_0 E_0^2$

4. The charge density of a sphere of radius R is given as $\rho = \rho_0 r$, where ρ_0 is a constant and r is the radius draws from the sphere's centre. The electric field at the surface of the sphere is

(1) $\frac{R^2\rho_0}{\pi\varepsilon_0}$ (2) $\frac{R^2\rho_0}{\varepsilon_0}$ (3) $\frac{R^2\rho_0}{4\pi\varepsilon_0}$ (4) $\frac{R^2\rho_0}{4\varepsilon_0}$

5. The mean radiation power of an electron B performing harmonic oscillations with amplitude 0.10 nm and frequency $\omega = 6.5\times10^{14}s^{-1}$ is

(1) $2\times10^{-15}W$ (2) $2.5\times10^{-15}W$ (3) $5\times10^{-15}W$ (4) $3\times10^{-15}W$

6. A current of 30 A in a flat circular coil having 100 closely wound turns of radius 10 cm. The flux density at the centre of the coil is

(1) $1.89\times10^{-3}Weber/m^2$

(2) $1.89\times10^{-4}Weber/m^2$

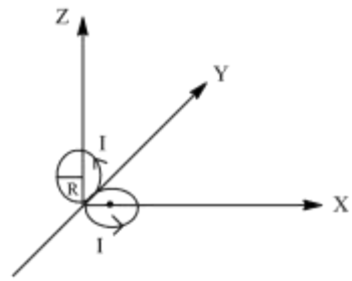
(3) $3.78\times10^{-3}Weber/m^2$

(4) $3.78\times10^{-3}Weber/m^2$

7. Two circular current loops of radius R each are shown in the figure given below. One loop is in YZ plane and another is in xy plane. Each loop carries a current I as shown. The magnetic dipole moment of the system is

(1) $\pi R^2 I$ (2) $2\pi R^2 I$

(3) $\sqrt{2}\pi R^2 I$ (4) $\frac{\pi r^2 I}{\sqrt{2}}$



8. The electric field inside the uniformly polarized sphere (polarization $\vec{P}$) of radius R is

(1) $-\frac{\vec{P}}{3\varepsilon_0}$ (2) $\frac{\vec{P}}{3\varepsilon_0}$ (3) $-\vec{P}$ (4) $\vec{P}$

9. The vector potential of an infinite solenoid with n turns unit length, radius R, and current I inside the solenoid is (r is the perpendicular distance from the axis of the solenoid)

(1) $\frac{\mu_0 nIr^2}{R}$ (2) $2\mu_0 nIr$ (3) $\frac{\mu_0 nIr}{2}$ (4) $\frac{\mu_0 nI}{2}\frac{R^2}{r}$

10. The magnetic vector potential is given as $\vec{A} = x^2\hat{j} + y^2\hat{i}$. The magnetic field is

(1) $(2x-2y)\hat{i}$ (2) $(2x-2y)\hat{k}$

(3) $(2x+2y)\hat{k}$ (4) $(-2x+2y)\hat{k}$

11. A relativistic particle with charge q and rest mass m_0 moves along a circle of radius r in a uniform magnetic field B. The kinetic energy of the particle is

(1) $m_0c^2\left[\sqrt{1+\left(\frac{qrB}{m_0c}\right)^2}-1\right]$ (2) $m_0c^2\left[\sqrt{1-\left(\frac{qrB}{m_0c}\right)^2}+1\right]$

(3) $\frac{(qrB)^2}{2m_0}$ (4) $m_0c^2\left[\sqrt{1+\left(\frac{qrB}{m_0c}\right)^2}+1\right]$

12. A capacitor of capacitance $1\mu F$ is discharged through resistance. The time taken for half the charge in the capacitor to leak is found to be 10 sec. The value of the resistance is

(1) $4.34\times10^6\Omega$ (2) $2.171\times10^6\Omega$

(3) $2.171\times10^5\Omega$ (4) $2.171\times10^4\Omega$

13. In a LCR circuit L = 10 mH, $C = 0.1\mu F$ $R = 200\,\Omega$. The frequency of the circuit is

(1) $477.5Hz$ (2) $4775Hz$ (3) $47750Hz$ (4) The circuit is not oscillatory

14. A spherical shell of radius R, carrying a uniform surface charge σ, is spinning at angular velocity $\vec{\omega}$. The vector potential produced at $\vec{r}$ (from the centre) outside the sphere is

(1) $\frac{\mu_0 R\sigma}{3}(\vec{\omega}\times\vec{r})$ (2) $\frac{\mu_0 R^2\sigma}{3r}(\vec{\omega}\times\vec{r})$ (3) $\frac{\mu_0 R^3\sigma}{3r^2}(\vec{\omega}\times\vec{r})$ (4) $\frac{\mu_0 R^4\sigma}{3r^3}(\vec{\omega}\times\vec{r})$

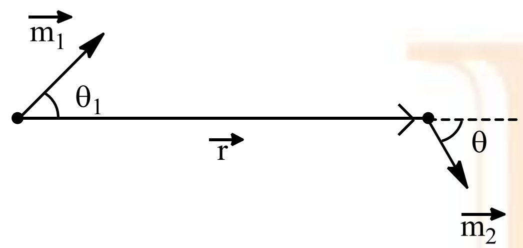
15. The magnetic field of a uniformly magnetized sphere (magnetization $\vec{m}$) inside the sphere is

(1) $\frac{1}{2}\mu_0\vec{M}$ (2) $-\frac{2}{3}\mu_0\vec{M}$ (3) $\frac{2}{3}\mu_0\vec{M}$ (4) $-\frac{1}{3}\mu_0\vec{M}$

16. A long copper rod of radius R carries a uniformly distributed current I. The magnetic field B inside the rod at distance r from the axis is (ignoring the magnetization)

(1) $\frac{\mu_0 I}{2\pi R}$ (2) $\frac{\mu_0 I}{\pi R}$ (3) $\frac{\mu_0 I}{2\pi}\frac{r}{R^2}$ (d) $\frac{\mu_0 I}{\pi}\frac{r}{R^2}$

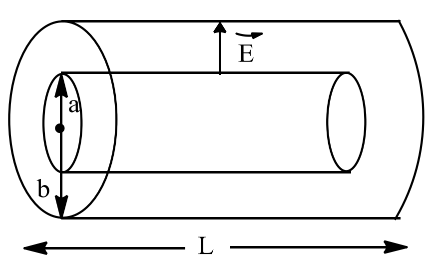
17. The interaction energy of two magnetic dipoles $\vec{m}_1$ & $\vec{m}_2$ separated by $\vec{r}$ is given by



(1) $\frac{\mu_0}{4\pi}\frac{1}{r^3}\left[\vec{m}_1.\vec{m}_2-3(\vec{m}_1.\hat{r})(\vec{m}_2.\hat{r})\right]$ (2) $\frac{\mu_0}{4\pi}\frac{1}{r^3}\vec{m}_1.\vec{m}_2$

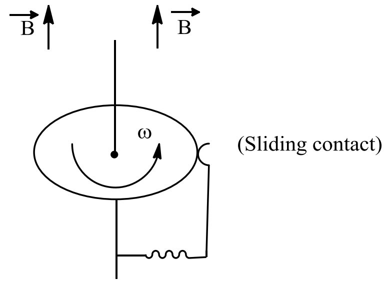
(3) $\frac{\mu_0}{4\pi}\frac{1}{r^3}\left[\vec{m}_1.\vec{m}_2+3(\vec{m}_1.\hat{r})(\vec{m}_2.\hat{r})\right]$ (4) $\frac{3\mu_0}{4\pi}\frac{1}{r^3}\left[(\vec{m}_1.\hat{r})(\vec{m}_2.\hat{r})\right]$

18. Two long coaxial metal cylinders of radii a and b are separated by material of conductivity σ. If they are maintained at a potential difference V, the current that flows from one to other in length L is



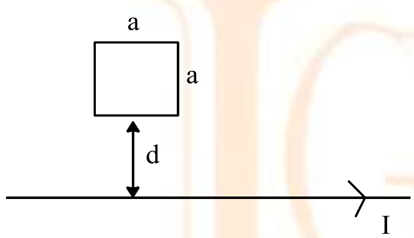
(1) $2\pi\sigma LV\ln\left(\frac{b}{a}\right)$ (2) $2\pi\sigma LV\ln\left(\frac{a}{b}\right)$ (3) $2\pi\sigma LV/\ln\left(\frac{b}{a}\right)$ (4) $2\pi\sigma LV/\ln\left(\frac{a}{b}\right)$

19. A metal disk of radius a rotates with angular velocity ω about a vertical axis through a uniform field $\vec{B}$, pointing up. A circuit is made by connecting one end of a resistor to the centre of the disc and the other end to a sliding contact which touches the outer edge of the disk. The current in the resistor is



(1) $\frac{\omega B a^2}{R}$ (2) $\frac{\omega B a^2}{2R}$ (3) $\frac{\omega B a^2}{3R}$ (4) $\frac{\omega B a^2}{4R}$

20. A square loop of wire (side a) lies on a table at a distance d from a very long straight wire which carries current I. (See the figure)



The magnetic flux through the loop is

(1) $\frac{a\mu_0 I}{2\pi}\ln\left(\frac{d}{a}\right)$ (2) $\frac{a\mu_0 I}{2\pi}\ln\left(\frac{a+d}{d}\right)$ (3) $\frac{a\mu_0 I}{2\pi}\ln\left(\frac{d}{a+d}\right)$ (4) $\frac{a\mu_0 I}{2\pi}\ln\left(\frac{a}{d}\right)$

21. Consider the previous problem, if the loop is pulled directly away from the wire with speed υ the emf generated is

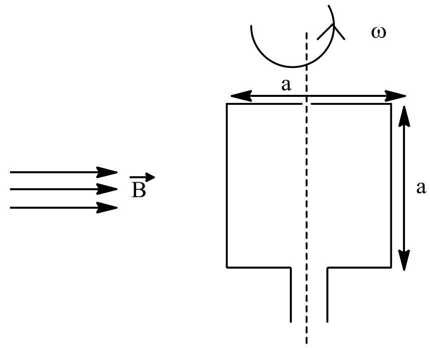
(1) $\frac{\mu_0 I v}{2\pi}\left(\frac{a+d^2}{a^2}\right)$ (2) $\frac{\mu_0 I v a}{2\pi d}$ (3) $\frac{\mu_0 I v a}{2\pi(a+d)}$ (4) $\frac{\mu_0 I a^2}{2\pi(ad+d^2)}$

22. What will be the direction of current in the loop in the previous question

(1) Clockwise (2) anticlock wise

(3) Depend on speed υ (4) depend on side of the loop

23. A square loop of side a is mounted on a vertical shaft and rotated at angular velocity ω (see the figure). A uniform magnetic field B points to the right. The emf $\varepsilon(t)$ is



(1) $Ba^2\omega\sin(\omega t)$ (2) $\frac{Ba^2\omega}{2}\sin\omega t$ (3) $2Ba^2\omega\sin(\omega t)$ (4) $\frac{Ba^2\omega}{4}\sin\omega t$

24. Light is incident on the interface of the two mediums having refractive indices n_1 & n_2 respectively. For normal incidence the reflection coefficient is

(1) $\frac{(n_1+n_2)^2}{4n_1n_2}$ (2) $\left(\frac{n_1-n_2}{n_1+n_2}\right)^2$ (3) $\frac{4n_1n_2}{(n_1+n_2)^2}$ (4) $\left(\frac{n_1+n_2}{n_1-n_2}\right)^2$

25. A point dipole $\vec{p}$ is located at a distance l from an infinite conducting plane. The $\vec{p}$ is perpendicular to the plane. The force on $\vec{p}$ is

(1) $\frac{p^2}{4\pi\varepsilon_0 l^4}$ (2) $\frac{p}{4\pi\varepsilon_0 l^3}$ (3) $\frac{3p^2}{32\pi\varepsilon_0 l^4}$ (4) $\frac{3p}{32\pi\varepsilon_0 l^3}$

26. The binding energy of proton in deuteron is
(1) 2.2 *MeV* (2) 7 *MeV* (3) 1.1 *MeV* (4) 8 *MeV*

27. The binding energy of neutron is deuteron is
(1) 2.2 *MeV* (2) 7 *MeV* (3) 1.1 MeV (4) 8 *MeV*

28. Which of the following nucleus is most stable
(1) ${}^{11}_{5}B$ (2) ${}^{4}_{2}He$ (3) ${}^{16}_{8}O$ (4) ${}^{12}_{6}C$

29. The single particle energy difference between the p-orbital's (i.e. $p_{3/2}$ and $p_{1/2}$) of a nucleus is 6 MeV. The difference between the states in its $1d$ orbital is:
(1) $-7MeV$ (2) $7MeV$ (3) $5MeV$ (4) $-5MeV$

30. The electric quadrupole moment of ${}^{19}_{9}F$ nucleus (according to shell model) is

(1) 0 (2) 0.366 b (3) $-0.036\,b$ (4) 0.036 b

31. The contribution of S state to the ground state of deuteron is

(1) 50% (2) 96% (3) 4% (4) 100%

32. The spin parity of ground state of deuteron is

(1) 1^+ (2) 1^- (3) 0^+ (4) 0^-

33. The spin parity of ${}^{91}_{38}Sr$ is

(1) $\left(\frac{5}{2}\right)^+$ (2) $\left(\frac{7}{2}\right)^+$ (3) $\left(\frac{7}{2}\right)^-$ (4) $\left(\frac{5}{2}\right)^-$

34. Which of the following is an acceptable potential for deuteron (Where λ is a positive constant)

(1) $\frac{1}{2}m\omega^2r^2+\lambda\vec{L}.\vec{S}$ (2) $-\frac{1}{2}m\omega^2r^2+\lambda\vec{L}.\vec{S}$

(3) $\frac{1}{2}m\omega^2r^2-\lambda\vec{L}.\vec{S}$ (4) $-\frac{1}{2}m\omega^2r^2-\lambda\vec{L}.\vec{S}$

35. The magnetic dipole moment of ${}^{14}_{7}N$ can be estimated as (using Schmidt model)

(1) $0.3735\mu_N$ (2) $-0.3735\mu_N$ (3) $3.735\mu_N$ (4) $-3.735\mu_N$

36. The magnetic dipole moment of ${}^{3}_{2}He$ is approximately

(a) $-1.91\mu_N$ (2) $2.79\mu_N$ (3) $1.91\mu_N$ (4) $-2.79\mu_N$

37. The magnetic quadrupole moment of ${}^{14}_{7}N$ is

(1) 0.36 units (2) 0 (3) 3.6 units (4) 2.5 units

38. The quark content of π^o meson is

(1) $|u\bar{u}\rangle$ (2) $|d\bar{d}\rangle$ (3) $\frac{1}{\sqrt{2}}\left(|u\bar{u}\rangle+|d\bar{d}\rangle\right)$ (4) $\frac{1}{\sqrt{2}}\left(|u\bar{u}\rangle-|d\bar{d}\rangle\right)$

39. Which of the following reaction is forbidden

(1) $\bar{\nu}_e+p\to n+e^+$ (2) $p\to n+e^++\nu_e$

(3) $\mu^-\to e^-+\bar{\nu}_e+\bar{\nu}_\mu$ (4) $\tau^-\to\mu^-+\bar{\nu}_\mu+\nu_\tau$

40. Which of the following process is allowed through strong force

(1) $p+\overset{\circ}{\wedge}\to\eta'+\mathrm{K}^+$ (2) $\overset{\circ}{\wedge}+\bar{p}\to K^-+\pi^o$

(3) $\bar{n}+p\to K^o+\pi^o$ (4) $\bar{p}\to\pi^-+\pi^o$

ANSWER KEY

TEST SEREIS # 2

E.M.T., NUCLEAR & PARTICLE PHYSICS

1.(3)	11.(1)	21.(4)	31.(2)
2.(2)	12.(*)	22.(2)	32.(1)
3.(1)	13.(2)	23.(1)	33.(1)
4.(4)	14.(4)	24.(2)	34.(3)
5.(3)	15.(3)	25.(3)	35.(1)
6.(1)	16.(3)	26.(1)	36.(1)
7.(3)	17.(1)	27.(1)	37.(2)
8.(1)	18.(3)	28.(3)	38.(4)
9.(3)	19.(2)	29.(*)	39.(3)
10.(2)	20.(1)	30.(3)	40.(2)