

Multiple Choice Questions

More than one choice could be correct.

1. If $\vec{r} = x\hat{a}_x + y\hat{a}_y + z\hat{a}_z$ and $r = |\vec{r}|$, then which of the following is not true?
 - (a) $\nabla r = \frac{\vec{r}}{r}$
 - (b) $\nabla^2(\vec{r} \cdot \vec{r}) = 6$
 - (c) $\vec{\nabla} \cdot \vec{r} = 1$
 - (d) $\vec{\nabla} \times \vec{r} = 0$
2. Plane $z = 10$ m carries charge 20 nC/m^2 . The electric field intensity at the origin is
 - (a) $-10 \hat{a}_z \text{ V/m}$
 - (b) $-18\pi \hat{a}_z \text{ V/m}$
 - (c) $-72\pi \hat{a}_z \text{ V/m}$
 - (d) $-360\pi \hat{a}_z \text{ V/m}$
3. Point charges 30 nC , -20 nC , and 10 nC are located at $(-1,0,2)$, $(0,0,0)$, and $(1,5,-1)$ respectively. The total flux leaving a cube of side 6 m centered at the origin.
 - (a) -20 nC
 - (b) 10 nC
 - (c) 20 nC
 - (d) 60 nC
4. An electron traveling horizontally enters a region where a uniform electric field is directed upward. What is the direction of the force exerted on the electron once it entered the field?
 - (a) To the left
 - (b) To the right
 - (c) Upward
 - (d) Downward
5. Two spheres of radius R_1 and R_2 are charged to the same potential. The charges on them are in the ratio

- (a) $R_1 : R_2$
- (b) $R_2 : R_1$
- (c) $R_1^2 : R_2^2$
- (d) $R_2^2 : R_1^2$

6. Consider the following cases:

- A point charge Q is placed at the origin. Let D_1 be the flux due to this charge over a sphere of radius b centered at the origin.
- A uniformly charged sphere of radius a ($a < b$) centered at the origin with a total charge of Q . Let D_2 be the flux due to this over a sphere of radius b centered at the origin is.

Which of the following is true

- (a) $D_1 = D_2$
- (b) $D_1 \neq D_2$
- (c) Under special conditions, $D_1 = D_2$

7. A potential field is given by $V = 3x^2y - yz$. Which of the following is not true?

- (a) At point $(1,0,-1)$, V and \vec{E} vanish.
- (b) $x^2y = 1$ is an equipotential line on the xy plane.
- (c) The equipotential surface $V = -8$ passes through point $P(2,-1,4)$.
- (d) The electric field at $P(2,-1,4)$ is $12\hat{a}_x - 8\hat{a}_y - \hat{a}_z$ V/m.

8. Which of the following is a source of magnetic fields

- (a) A DC current in a wire
- (b) A permanent magnet
- (c) A charged disk rotating at uniform speed
- (d) A time varying electric field

9. Faraday's law states that the induced EMF is

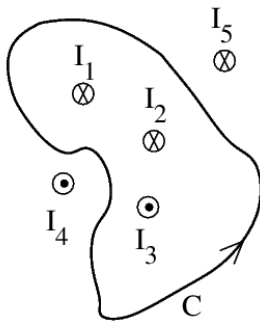
- (a) Proportional to the change in magnetic flux linkage
- (b) Equal to the negative rate of change of magnetic flux linkage
- (c) Equal to the negative change in magnetic flux linkage
- (d) Equal to the change of magnetic flux

10. Plane $y = 0$ carries a uniform current of $30\hat{a}_z$ mA/m. At $(1,10,-2)$, the magnetic field intensity is

- (a) $-15 \hat{a}_x$ mA/m
- (b) $15 \hat{a}_x$ mA/m

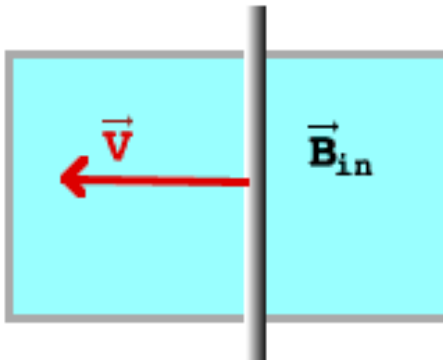
- (c) $477.5 \hat{a}_y \mu\text{A/m}$
- (d) $18.85 \hat{a}_y \text{nA/m}$

11. Which of these statements is not characteristic of a static magnetic field?
- (a) It is solenoidal
 - (b) Can produce a magnetic field
 - (c) It has not sinks or sources
 - (d) Magnetic flux lines are always closed
12. Two identical coaxial circular coils carry the same current I but in opposite directions. The magnitude of the magnetic field \vec{B} at a point on the axis midway between the coil is
- (a) Zero
 - (b) The same as that produces by one coil
 - (c) Twice that produced by one coil
 - (d) Half that produced by one coil
13. According to Ampere's Law, the path integral $\oint_C \vec{B} \cdot d\vec{l}$ around the closed loop C is given by



- (a) $\mu_0(I_1 + I_2 - I_3)$
 - (b) $\mu_0(-I_1 - I_2 + I_3)$
 - (c) $\mu_0(I_1 + I_2 + I_3)$
 - (d) $-\mu_0(I_1 + I_2 + I_3)$
14. Two thin parallel wire carrying currents along the same direction. The force experienced by one due to the other is
- (a) Parallel to the lines
 - (b) Perpendicular to the lines and attractive
 - (c) Perpendicular to the lines and repulsive

- (d) Zero
15. Which of these formulas is wrong?
- (a) $B_{\perp A} = B_{\perp B}$
 - (b) $B = \sqrt{B_{\perp}^2 + B_{\parallel}^2}$
 - (c) $H = H_{\perp} + H_{\parallel}$
 - (d) $H_{\parallel A} - H_{\parallel B} = K$
16. The work done on a charged particle by a magnetic field is
- (a) Always positive
 - (b) Always Negative
 - (c) Zero
 - (d) Not defined.
17. The flux through each turn of a 100-turn coil is $(t^3 - 2t)$ mWb, where t is in seconds. The induced emf at $t = 2$ s is
- (a) 1 V
 - (b) -1 V
 - (c) 4 mV
 - (d) 0.4 V
18. The metal rod in the figure is sliding along a U-shaped track as shown. There is a magnetic field in the inside the track which is into the figure. What is the direction of the current in the sliding rod?



- (a) Up
- (b) There is no current
- (c) Down
- (d) Depends on the magnitude of the magnetic field

19. In the above question, if $B = 0.4 \text{ T}$, $L = 0.5 \text{ m}$, and $v = 3 \text{ m/s}$, what is the magnitude of the induced EMF?
- (a) 3 V
 - (b) 2.6 V
 - (c) 0.6 V
 - (d) 0 V
20. A $10 \mu\text{F}$ electrolytic capacitor connected to a 6 V power supply is fully charged. The displacement current flowing through the dielectric is
- (a) 100 mA
 - (b) 10 mA
 - (c) 1 mA
 - (d) Zero
21. Which of these function does not satisfy the wave equation?
- (a) $50e^{jw(t-3z)}$
 - (b) $\sin(w(10z + 5t))$
 - (c) $(x + 2t)^2$
 - (d) $\cos^2(y + 5t)$
22. Which of the following statement is not true about waves in general?
- (a) The phenomenon may be a function of time only
 - (b) The phenomenon may be sinusoidal
 - (c) The phenomenon must be a function of time and space
 - (d) For practical reasons, it must be finite in extent
23. The \vec{E} and \vec{B} fields in electromagnetic waves are oriented
- (a) parallel to the wave's direction of travel, as well as to each other.
 - (b) parallel to the waves direction of travel, and perpendicular to each other.
 - (c) perpendicular to the wave's direction of travel, and parallel to each other.
 - (d) perpendicular to the wave's direction of travel, and also to each other.
24. For an electromagnetic wave, the direction of $\vec{E} \times \vec{B}$ gives the direction of
- (a) Electric Field
 - (b) Magnetic Field
 - (c) Wave propagation
 - (d) The emf induced by the wave

25. What is the wavelength of light waves in free space, if the frequency is 5×10^{14} ?
- (a) 0.6 m
 - (b) 6 mm
 - (c) 0.06 mm
 - (d) $0.6 \mu\text{m}$

Answers

1. (b). Use the expressions for ∇ operator to find the solution.
2. (d). Use Gauss' law to find the field.
3. (b). Use Gauss' law. The contribution to flux is only due to charges located at $(-1,0,2)$ and $(0,0,0)$ since they are inside the cube.
4. (d). Using Coulomb's law.
5. (a). Potential is given by $\frac{kQ}{R}$.
6. (a). Gauss' law.
7. (a).
8. (a),(b),(c),(d). All of them are a sources of magnetic fields.
9. (b). Definition of Faraday's law.
10. (a). Use Ampere's law.
11. (b). Static magnetic fields can't produce EMF.
12. (a). Use Biot-Savart's law.
13. (b). Ampere's law.
14. (b).
15. (c).
16. (c). Force by a magnetic field on an electron is always perpendicular to velocity.
So work is zero.
17. (b). Faraday's law.
18. (c).
19. (c).
20. (d). Fully charged capacitor does not have displacement current.
21. (d). Helmholtz's equation.
22. (a). EM waves need to be a function to time and space.
23. (d).
24. (c).
25. (d). $v = \lambda\nu$