1. A vector of magnitude 10 points from the point $(5, 5\pi/4, 0)$ in cylindrical coordinates toward the origin. This vector in Cartesian coordinates is:

(a) $5a_x - 5a_y$ (b) $-7.07a_x - 7.07a_y$ (c) $5a_x + 5a_y$ (d) $7.07a_x + 7.07a_y$ (e) $10a_x + 10a_y$

2. The volume of the parallelepiped whose edges are the vectors **A**, **B**, and **C**, is given by the magnitude of:

(a) $\mathbf{A}\cdot(\mathbf{B}\times\mathbf{C})$ (b) $\mathbf{A}\times(\mathbf{B}\times\mathbf{C})$ (c) $\mathbf{A}\times(\mathbf{B}\cdot\mathbf{C})$ (d) $\mathbf{A}\times(\mathbf{B}+\mathbf{C})$ (e) $\mathbf{A}\cdot(\mathbf{B}\cdot\mathbf{C})$

3. A charge distribution in spherical coordinates is given by $\rho_v(r) = 5re^{-2r}$ (C/m³). Using Gauss's law, the value of $\nabla\cdot(\varepsilon\mathbf{E})$ at the point $(0.5, 2\pi/3, 0)$ is:

(a) $2.5e^{-1}$ (C/m²) (b) $2.5e^{-1}$ (V/m) (c) $2.5e^{-1}$ (C/m³) (d) $5e^{-1}$ (C/m²) (e) We need the value of ε

4. One of the following is not a property of a conservative electrostatic field:

(a) $E = -\nabla V$ (b) $\nabla\times\mathbf{E} = 0$ (c) $q\oint E\cdot dl = 0$ (d) $\int_a^b E\cdot dl = 0$ (e) None of these

5. When lightening occurs between the clouds themselves, or between the clouds and the earth, very large current flows through the air. This is an example of a conduction current:

(a) True (b) False

6. When a potential of 10 V is applied to a mercury column in a cylindrical container, the current is 2 A. If the mercury is now poured into another cylindrical container of twice the radius, and the same potential of 10 V is applied across its ends, what is the current now?

(a) 32 A (b) 8 A (c) 0.125 A (d) 4 A (e) 0.5 A

7. Kirchhoff's current law has its origin in the following equation:

(a) $\nabla\times\mathbf{H} = \mathbf{J}$ (b) $\nabla\cdot\mathbf{J} = 0$ (c) $\nabla\times\mathbf{E} = 0$ (d) $\nabla\cdot\mathbf{B} = 0$ (e) $\nabla\cdot\mathbf{D} = \rho_v$

8. A parallel-plate capacitor connected to a battery stores twice as much energy with a given dielectric as it does with air as dielectric. The susceptibility of the dielectric is:

(a) 0 (b) 3 (c) 2 (d) 4 (e) 1

9. If a point charge of +2 pC is brought near (but not contacting) a neutral, isolated conducting sphere of radius a, the total charge on the surface of the sphere will be:

(a) +2 pC (b) –2 pC (c) +4 pC (d) –1 pC (e) 0

10. The electric flux density at a point on the surface of a conductor is given by $\mathbf{D} = 0.2a_x - 0.3a_y - 0.2a_z$ (pC/m²). The charge density on the surface of the conductor at the point is:

(a) 0.276 pC/m² (b) –0.325 pC/m² (c) 0.412 pC/m² (d) -0.2 pC/m² (e) -0.3 pC/m²

11. The capacitance of two conducting spherical shells of radius a in air and separated by a distance $d \gg a$, is:

(a) $2\pi\varepsilon_0 a$ (b) $4\pi\varepsilon_0 a$ (c) $\pi\varepsilon_0 a$ (d) $8\pi\varepsilon_0 a$ (e) none of these

12. When M point charges were placed between two semi-infinite conducting planes inclined to each other at an angle of 120°, the total number of charges (original+images) was 12. Therefore, M is equal to:

(a) 4 (b) 6 (c) 3 (d) 2 (e) 1

13. The two dimensional Laplace equation $V_{xx} + V_{yy} = 0$ in the region $0 \le x \le a$, $0 \le y \le b$, has a solution of the form $V(x,y) = X(x)Y(y)$ subject to the B.C.s $V(0,y) = V(a,y) = 0$. Therefore, $X(x)$ could be:

(a) $\cos(n\pi x/a)$ (b) $\sin(n\pi x/b)$ (c) $\cos(n\pi x/a)$ (d) $\sin(n\pi x/a)$ (e) $\cosh(n\pi x/a)$

14. In cylindrical coordinates, $\mathbf{B} = (2.0/\rho)\mathbf{a}_\phi$ (T). The magnetic flux that crosses the plane surface defined by $0.5 \le \rho \le 2.5$ m and $0 \le z \le 2.0$ m is:

(a) 8 Wb (b) 6.44 Wb (c) 5.32 Wb (d) –5.32 Wb (e) 10.1 Wb

15. A current strip 2 cm wide lies in the x-y plane, and carries a current of 15 A in the a_x direction. Assuming the current is uniformly distributed over the strip width and $\mathbf{B} = 0.2a_y$ T, then the force on the strip per unit length is:

(a) $-3.0a_y$ N/m (b) $30a_y$ N/m (c) $30a_z$ N/m (d) $3.0a_z$ N/m (e) $60a_z$ N/m

16. Two infinite current sheets, each of constant density K_0, are parallel and have their currents oppositely directed. The force per unit area on either sheet is:

(a) $\mu_0 K_0^2/2$ repulsion (b) $\mu_0 K_0^2/2$ attraction (c) $\mu_0 K_0/2$ attraction (d) $2\mu_0 K_0^2$ repulsion

17. In a certain region, **E** and **B** fields are uniform and oriented at right angles to each other. A proton enters the region with a speed of 10^6 m/s at right angle to both fields and passes the region undeflected. If $|\mathbf{B}| = 0.5$ mT, then $|\mathbf{E}|$ =:

(a) 2 KV/m (b) 50 V/m (c) 500 V/m (d) 200 V/m (e) We need Q and m of the proton

18. The positive x-axis carries a current of $-12a_x$ A. The magnetic field **H** at the point (0, 0, -3m) is:

(a) $(-1/\pi)a_y$ (A/m) (b) $(4/\pi)a_y$ (A/m) (c) $(-1/\pi)a_x$ (A/m) (d) $(-2/\pi)a_z$ (A/m) (e) $(3/\pi)a_y$ (A/m)

19. A toroid with a mean radius of 10cm carries a current of 5A and has a turn density of 4 turns/rad. The magnetic field **H** inside the toroid is:

(a) 31.83 A/m (b) 200 A/m (c) 1256.6 A/m (d) 100 A/m (e) 20 A/m

20. A bar magnet is successively divided in half 10 times. At the end, how many separate magnetic dipoles do we have?

(a) 40 (b) 0 (c) 20 (d) $(1024)^2$ (e) 1024

21. Since $\nabla\cdot\mathbf{B} = 0$, then we can write $\mathbf{B} = \nabla\times\mathbf{A}$, and therefore the magnetic flux can be written as $\Psi_m = \iiint(\nabla \cdot A)dv$.

(a) True (b) False

22. One of the following is not a Maxwell equation for the static fields in a linear, homogeneous medium:

(a) $\nabla\cdot\mathbf{H} = 0$ (b) $\nabla\times\mathbf{J} = \mathbf{H}$ (c) $\nabla\times\mathbf{D} = 0$ (d) $\oint B \cdot dl = \mu_0 I$ (e) $\nabla\cdot\mathbf{E} = \rho_v/\varepsilon$

23. An electron is orbiting in a circular path of radius 0.5×10^{-10} m with an angular velocity of 4×10^{16} rad/s. If $|\mathbf{B}| = 0.4$ nT, what is the maximum torque on this electron?

(a) 2×10^6 N.m (b) 5.25×10^{-16} N.m (c) 3.2×10^{-27} N.m (d) 8×10^{26} N.m (e) 1.25×10^{-27} N.m

24. In a ferromagnetic material ($\mu = 20\mu_0$), $\mathbf{B} = 4a_y$ mT. In this material, the magnetization vector **M** is =:

(a) $3024a_y$ (A/m) (b) $3351a_y$ (A/m) (c) $3.8a_y$ (mA/m) (d) $3664a_y$ (A/m) (e) $2414a_y$ (A/m)

25. The unit of inductance is:

(a) F/m (b) Joule/C (c) Ohm.s (d) Wb/m (e) A/s

Good Luck