1. A closed surface, in the shape of a cylinder of radius R and Length L, is placed in a region with a constant electric field of magnitude E. The total electric flux through the cylindrical surface is
   (A) $E\pi R^2$   (B) zero   (C) $E 2\pi R L$   (D) $E \pi R^2 L$   (E) $E \pi RL$

2. Which of the following represents the electric field due to an infinite charged sheet with a uniform charge distribution $\sigma$.
   (A) zero   (B) $\sigma$   (C) $\sigma/\varepsilon_0$   (D) $2\sigma/\varepsilon_0$   (E) $\sigma/\varepsilon_0$

3. Two large parallel sheets charged with equal but opposite charges. What is the electric field in the space between the sheets?
   (A) zero   (B) $\sigma/\varepsilon_0$   (C) $2\sigma/\varepsilon_0$   (D) $\sigma/2\varepsilon_0$   (E) $\sigma$
4. Two conducting concentric spherical shells are shown above. The electric field due to the charged shells is presented by field lines. What is the charge on the outer shell if the inner shell is charged with a positive charge Q.
(A) -2 Q (B) -Q (C) 0 (D) Q (E) 2 Q

5. Which of the following statements about conductors under electrostatic conditions is true?
(A) Charge placed on the conductor always spreads evenly throughout the entire volume.
(B) Charge placed on the conductor always spreads evenly over the surface.
(C) The charge surface density is always a constant.
(D) The electric field at the surface of a conductor is tangent to the surface.
(E) The electric field at the surface of a conductor is perpendicular to the surface.

6. The net electric flux through a closed surface
   (A) depends on the size of Gaussian surface
   (B) depends on the shape of Gaussian surface
   (C) is zero if only negative charges are enclosed by the Gaussian surface
   (D) is zero if only positive charges are enclosed by the Gaussian surface
   (E) is zero if the net charge enclosed by the Gaussian surface is zero
7. A conducting sphere of radius R carries a charge Q. Another conducting sphere has a radius R/2, but carries the same charge. The spheres are far apart. The ratio of the electric field near the surface of the smaller sphere to the field near the surface of the larger sphere is most nearly
(A) 1/4  (B) 1/2  (C) 1  (D) 2  (E) 4

Questions 8-9

Two concentric, spherical conducting shells have radii a and b and charges Q_1 and Q_2, as shown above.

8. In the region where r<a the electric field is proportional to
(A) Q_1/r^2  (B) (Q_1 + Q_2)/b^2  (C) zero  (D) Q_1/a + Q_2/b  (E) Q_1/a^2 + Q_2/b^2

9. In the region a<r<b the electric field is proportional to
(A) Q_1/r^2  (B) (Q_1 + Q_2)/r^2  (C) zero  (D) Q_1/a + Q_2/b  (E) (Q_1+Q_2)/r

10. A solid nonconducting sphere of radius R has a charge Q uniformly distributed throughout its volume. A Gaussian surface of radius r with r < R is used to calculate the magnitude of the electric field E at a distance r from the center of the sphere. Which of the following equations results from a correct application of Gauss's law for this situation?
(A) E(4\pi R^2) = Q/\varepsilon_o  (B) E(4\pi r^2) = Q/\varepsilon_o  (C) E(4\pi r^2) = (Q^3 r^3)/(\varepsilon_o 4\pi R)
(D) E(4\pi r^2) = (Qr^3)/(\varepsilon_o R^3)  (E) E(4\pi r^2) = 0
11. A sphere of radius R has positive charge Q uniformly distributed throughout its volume. Which of the following is the electric field inside the sphere r < R?
   (A) 0  (B) kQr/R^3  (C) kQ/r^2  (D) kQ/R^3  (E) kQ/r

12. A sphere of radius R has positive charge Q uniformly distributed throughout its volume. Which of the following is the electric field outside the sphere r > R?
   (A) 0  (B) kQr/R^3  (C) kQ/r^2  (D) kQ/R^3  (E) kQ/r

13. A sphere of radius R has positive charge Q uniformly distributed throughout its volume. Which of the following is the electric field outside the sphere r > R?

14. Gauss's law provides a convenient way to calculate the electric field outside and near each of the following isolated charged conductors EXCEPT a
   (A) large plate  (B) sphere  (C) cube  (D) long, solid rod  (E) long, hollow cylinder
The diagram above shows 2 oppositely charged parallel plates each with a uniform electric field \( E \).

15. What is the magnitude and direction of the electric field at point A?
(A) \( E \) to the left 
(B) \( E \) to the right 
(C) zero no direction 
(D) \( 2E \) to the right 
(E) \( 2E \) to the left

16. What is the magnitude and direction of the electric field at point B?
(A) \( E \) to the left 
(B) \( E \) to the right 
(C) zero no direction 
(D) \( 2E \) to the right 
(E) \( 2E \) to the left

17. A uniform electric field \( E \) with magnitude \( 3.0 \times 10^3 \) N/C passes through a disk of radius 0.2 m \( 30^\circ \) above the normal line as shown above. Approximately what is electric flux through the disk?
(A) 0 Wb 
(B) \( 60\pi\sqrt{3} \) Wb 
(C) \( 30\pi\sqrt{3} \) Wb 
(D) \( 20\pi\sqrt{2} \) Nm\(^2/C \) 
(E) \( 80\pi\sqrt{5} \) Wb
Questions 18-20
The figure below shows a cylindrical distribution of charge Q with radius R and constant charge density \( \rho \). (Assuming L>>R)

![Cylindrical Charge Distribution](image)

18. Which of the following is the electric field inside the cylinder?
   (A) \( \frac{pr}{\epsilon_0} \)  
   (B) \( \frac{pr}{2\epsilon_0} \)  
   (C) zero  
   (D) \( \frac{pR}{\epsilon_0 r} \)  
   (D) \( \frac{pr}{4\epsilon_0 R} \)

19. Which of the following is the electric field outside the cylinder?
   (A) \( \frac{pR^2}{2\epsilon_0 r} \)  
   (B) \( \frac{pr}{\epsilon_0} \)  
   (C) zero  
   (D) \( \frac{pr}{2\epsilon_0} \)  
   (E) \( \frac{pR}{4\epsilon_0} \)

20. Which of the following graphs best represents the electric field strength E as a function of the distance r from the center of the cylinder?

   (A) ![Graph A](image)  
   (B) ![Graph B](image)  
   (C) ![Graph C](image)  
   (D) ![Graph D](image)  
   (E) ![Graph E](image)
Answers
1. B
2. C
3. B
4. E
5. E
6. E
7. E
8. C
9. A
10. D
11. B
12. C
13. B
14. C
15. D
16. C
17. B
18. B
19. A
20. A