

1. What is the electric field created by a long, straight wire carrying a total charge of $+Q$, distributed uniformly along its entire length, L at a distance r from the wire?

- A) $Q/2\pi L\epsilon_0 r$
- B) $-Q/2\pi L\epsilon_0 r$
- C) $Q/4\pi L\epsilon_0 r$
- D) $2\pi\epsilon_0 rQ/L$
- E) $2\pi\epsilon_0 rQ/L$

2. The negative derivative of electric potential with respect to radius is equal to

- A) charge
- B) electric force
- C) electric field
- D) capacitance
- E) potential energy

3. What is the potential due to a spherical shell of radius R for $r > R$?

- A) kQ/r
- B) kQ/r^2
- C) kQ^2/r
- D) kQ/R
- E) kQ^2/R

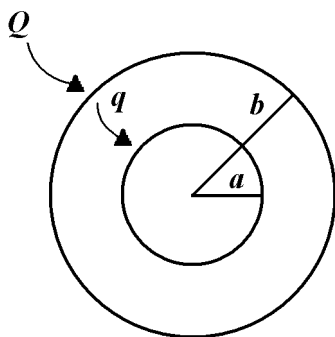
4. What is the potential due to a spherical shell of radius R for $r < R$?

- A) kQ/r
- B) kQ/r^2
- C) kQ^2/r
- D) kQ/R
- E) kQ^2/R

5. What is the ratio of potential due to a spherical shell of radius R and a solid conducting sphere of radius R , for $r < R$?

- A) 1:1
- B) 1:2
- C) 2:1
- D) -1:1
- E) -1:2

6.



The figure above shows two concentric, conducting, thin spherical shells of radii a and b , and charges q and Q . What is the work required to bring a test charge of q_0 from the outer shell to the inner shell?

- A) $kQq(a-b)$
- B) $kQq(b-a)$
- C) $kQq(1/a-1/b)$
- D) $kQq/(b-a)^2$
- E) $kQq/(b-a)$

7. What is the electric potential of a very long conducting cylinder of radius R and a uniform linear charge density λ a distance r away from the center of the cylinder?

- A) $k\lambda \ln(R/r)$
- B) $2k\lambda \ln(R/r)$
- C) $4k\lambda \ln(R/r)$
- D) $2k/\lambda \ln(R/r)$
- E) $k/\lambda \ln(R/r)$

8. The electric potential a distance r away from a cylinder can be calculated by dividing a charge q into

- A) the work done on the magnetic field as a charge q moves from a point on the cylinder to a point outside the cylinder.
- B) the work done on the magnetic field as a charge q moves from a point on the cylinder to a point inside the cylinder.
- C) the work done on the electric field as a charge q moves from a point on the cylinder to a point outside the cylinder.
- D) the work done on the electric field as a charge q moves from a point on the cylinder to a point inside the cylinder.
- E) the force on a charge q as it moves from a point on the cylinder to a point inside the cylinder.

9. A conducting spherical shell of radius R carries a charge Q . What is the potential inside the sphere a distance r away from the center?

- A) KQ/r
- B) KQ/R
- C) KQ/r^2
- D) KQ/R^2
- E) $KQ/2R$

10. All of the following about a sphere of charge that has spherical symmetry are true **EXCEPT**

- A) The electric field and the potential outside of the distribution is the same as if all the charge was concentrated at the center of the sphere
- B) A charged metal shell produces the field of an ordinary point charge
- C) Inside a charged metal shell the electric field and the potential are equal to zero
- D) All of the charge on a solid metal sphere resides on the surface
- E) The electric field inside a solid metal sphere is zero and the potential is constant

11. All of the following are true about an infinitely long cylindrically symmetric distribution of charge **EXCEPT**
- A) The electric field is perpendicular to the axis of the cylinder
 - B) For a positive charge, the electric field points away from the cylinder axis
 - C) For a positive charge, the potential decreases as the distance to the cylinder axis increases
 - D) The potential difference between two points outside the distribution is the derivative of the electric field
 - E) For a negative charge, the electric field points towards the cylinder axis
12. What is the potential due to a spherical shell with charge Q of radius R for $r = R$?
- A) 0
 - B) kQ/R
 - C) kQ^2/R
 - D) $-kQ/R$
 - E) $-kQ/R^2$

Base your answers to questions **13** through **15** on the information below.

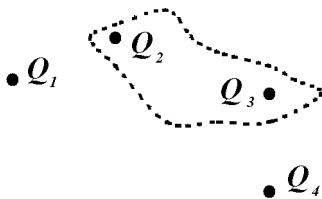
A conducting cylindrical shell of inner radius a and outer radius b initially has a charge of $+Q$. A wire of the same length as the cylindrical shell with charge $-Q$ is then inserted along the axis of the cylindrical shell.

13. What is the charge on the cylindrical shell after the wire is put inside it?
- A) 0
 - B) Q/a
 - C) Q/b
 - D) $Q/2$
 - E) Q

14. What is the electric field at a distance of $r < a$?
- A) 0
 - B) kQ/a^2
 - C) kQ/r^2
 - D) $-kQ/r^2$
 - E) $-kQr/(a^2 + b^2)^{3/2}$
15. If the charge on the wire were changed to $+Q$, what is now the charge on the outer surface of the cylinder?
- A) 0
 - B) $-Q$
 - C) $-2Q$
 - D) $+Q$
 - E) $+2Q$
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16. The potential at a point outside of a very long conducting cylinder of radius R and uniform charge density λ relative to the potential on the cylinder is given by the equation $V(r) = 2k\lambda \ln(R/r)$. What is the electric field at some distance r from the center of the cylinder?
- A) $-k\lambda/2r$
 - B) $-k\lambda/r$
 - C) $-2k\lambda/r$
 - D) $-4k\lambda/r$
 - E) $-\lambda/r$
17. The potential difference due to a finite rod along the x-axis is given by the equation $V(x) = C[\ln(x + L) - \ln(x)]$, where C and L are constants. What is the electric field due to this rod?
- A) $-C/x$
 - B) $-C[1/(x + L) - 1/x]$
 - C) $-C/(x + L)$
 - D) $-C/L$
 - E) $1/(x + L) - 1/x$

18. If the electric potential of a system is given by the equation $V(r) = 5\ln(r^2)$, what is the equation for the electric field in this system?
- A) $5\ln(r^2)/r$
B) $-5r\ln(r^2)$
C) $5/r^2$
D) $-10/r$
E) $10/r^2$
19. The negative integral of electric field with respect to radius is which of the following?
- A) electrostatic force
B) electric potential
C) electric potential energy
D) charge
E) capacitance
20. The potential of a non-uniform cloud of charge is given by $V(r) = Kr^2$, where r is the distance from the center of the cloud. What is the electric field as a function of r ?
- A) $-2Kr$
B) $2Kr$
C) $Kr^3/3$
D) $-Kr$
E) $-Kr^2$
21. What is the electric field created by a very large rectangular plate with a surface charge density of $+\sigma$, where σ is charge per unit area?
- A) $\sigma/2\epsilon_0$
B) σ/ϵ_0
C) $2\sigma/\epsilon_0$
D) $\sigma/2\epsilon_0$
E) σ/ϵ_0
22. Which shape Gaussian surface is most likely to be used to calculate the electric field for a long, straight wire?
- A) sphere
B) circle
C) cylinder
D) rectangle
E) line
23. Which shape Gaussian surface is most likely to be used to calculate the electric field for a very large rectangular plate?
- A) rectangle
B) sphere
C) circle
D) cylinder
E) line
24. What is the electric field inside a charged hollow metal sphere?
- A) **Zero**
B) kq/r^2
C) kq/r
D) kq/r^2
E) kq/r

25.



The Gaussian surface above is the area enclosed by the dotted line. The net flux through the Gaussian surface depends on which of the following charges?

- A) All four
 - B) Q_2 and Q_3
 - C) Q_1 and Q_4
 - D) Q_1 and Q_2
 - E) Q_3 and Q_4
26. What is the net flux due to a $+4Q$, $-2Q$ and $+Q$ charge in an enclosed area of 4 m^2 ?
- A) Q/ϵ_0
 - B) $2Q/\epsilon_0$
 - C) $3Q/\epsilon_0$
 - D) $4Q/\epsilon_0$
 - E) $12Q/\epsilon_0$
27. What is the enclosed charge in an area if the net flux due to that charge contained in the area is $3 \text{ Nm}^2/\text{C}$?
- A) Zero
 - B) $\epsilon_0/9$
 - C) $\epsilon_0/3$
 - D) $3\epsilon_0$
 - E) $9\epsilon_0$

28. What is the net flux of a Gaussian surface enclosing an electric dipole?

- A) Zero
 - B) Q/ϵ_0
 - C) $2Q/\epsilon_0$
 - D) $-Q/\epsilon_0$
 - E) $-2Q/\epsilon_0$
29. All of the following are true about Gauss' law **EXCEPT**
- A) Gauss' law refers to the flux through a closed surface.
 - B) Gauss' law states that the flux through the closed surface is proportional to the total charge within the surface.
 - C) Gauss' law is useful when the electric field is perpendicular to the differential area.
 - D) Gauss' law is useful when the electric field is zero.
 - E) A rectangle is an example of a Gaussian surface.
30. What is the electric field created by a spherical capacitor of radius R with charge $+Q$ on the outer plate at a distance r from the center of the capacitor where $r > R$?
- A) 0
 - B) $Q/2\pi\epsilon_0 r^2$
 - C) $Q/4\pi\epsilon_0 r^2$
 - D) $-Q/2\pi\epsilon_0 r^2$
 - E) $-Q/4\pi\epsilon_0 r^2$
31. All of the following are true about Gauss' Law **EXCEPT**
- A) It is one of Maxwell's Equations.
 - B) It involves a line integral.
 - C) It is helpful in finding the electric field associated with a charge.
 - D) It says that the electric field is dependent on the enclosed charge of the Gaussian surface.
 - E) The permittivity of free space is included in the formal statement of Gauss' Law.

32. Based on Gauss' Law, which of the following affects the electric flux through a Gaussian surface?

- A) a magnetic monopole enclosed by the surface
- B) a magnetic dipole outside of the surface
- C) a stationary electric charge enclosed by the surface
- D) a stationary electric charge outside the surface
- E) a charge moving with a constant velocity outside the surface

33. What is the electric flux through a cylinder of radius r and height h due to a charged plane parallel to the base of the cylinder with charge density σ that cuts through the cylinder?

- A) σ/E_0
- B) $\sigma/2E_0$
- C) $r^2\sigma/4E_0$
- D) $\rho r^2\sigma/E_0$
- E) $\rho r^2\sigma/2E_0$

34. Which of the following pairs of charge distributions and Gaussian surfaces are correctly paired such that the Gaussian surface can be used to find the electric field associated with that charge distribution?

- A) plane and sphere
- B) plane and cylinder
- C) plane and rectangle
- D) infinite line and rectangle
- E) infinite line and sphere

35. The electric field near each of the following charged objects can be determined easily using Gauss' Law **EXCEPT**

- A) a spherical shell
- B) a solid sphere
- C) a long, solid cylinder
- D) a long, hollow cylinder
- E) an arc

36. The potential of a point-charge is given by the equation $V(r) = kq/r$. Determine the electric field at some distance r from q .

- A) $-kq/r^2$
- B) kq/r^2
- C) kqr
- D) $-kqr$
- E) $-kq/r$

Answer Key
E & V Calculus MC Questions [Mar 28, 2011]

1. A
2. C
3. A
4. D
5. A
6. C
7. B
8. C
9. B
10. C
11. D
12. B
13. E
14. D
15. E
16. C
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29. E
30. A

31. B
 32. C
 33. E
 34. B
 35. E
 36. B
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