General Physics 2
Fall 2021
Midterm Examination
21 October 2021

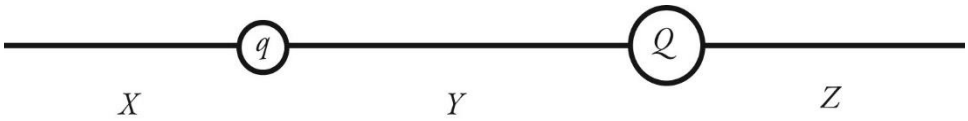
Please answer all the questions below.
Record your answers in the JBNU LMS. Click on the Quiz and record your answer in the Midterm.
Time: 9.00 – 10.30 am

1) Two identical small charged spheres are a certain distance apart, and each one initially experiences an electrostatic force of magnitude F due to the other. With time, charge gradually leaks off of both spheres. When each of the spheres has lost half its initial charge, the magnitude of the electrostatic force will be
A) 1/16 F.
B) 1/8 F.
C) 1/4 F.
D) 1/2 F.

2) A point charge Q is located a short distance from a point charge $3Q$, and no other charges are present. If the electrical force on Q is F, what is the electrical force on $3Q$?
A) $F/3$
B) $F/\sqrt{3}$
C) F
D) $\sqrt{3}F$
E) $3F$

3) When two point charges are a distance d part, the electric force that each one feels from the other has magnitude F. In order to make this force twice as strong, the distance would have to be changed to
A) $2d$.
B) $\sqrt{2}d$.
C) $d/\sqrt{2}$.
D) $d/2$.
E) $d/4$.

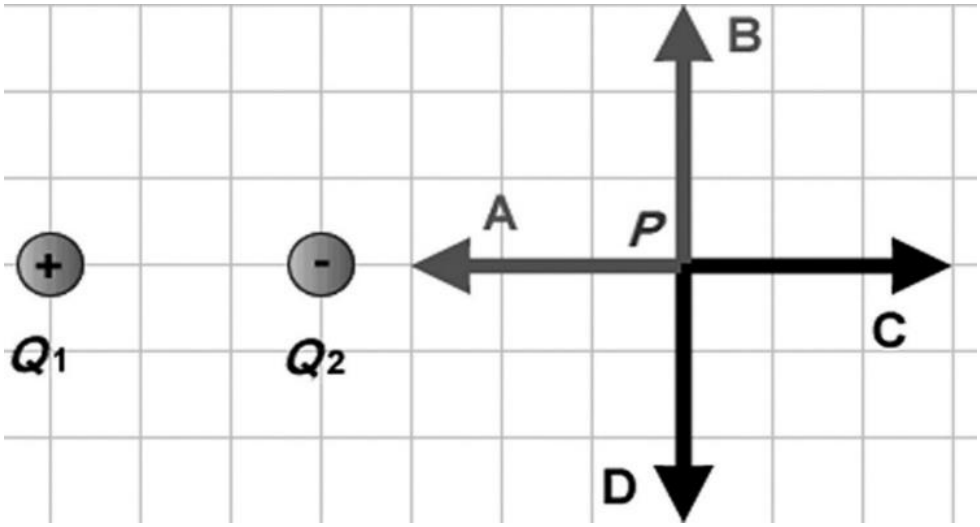
4) The figure shows two unequal point charges, q and Q, of opposite sign. Charge Q has greater magnitude than charge q. In which of the regions X, Y, Z will there be a point at which the net electric field due to these two charges is zero?



A) only regions X and Z
B) only region X
C) only region Y

D) only region *Z*
E) all three regions

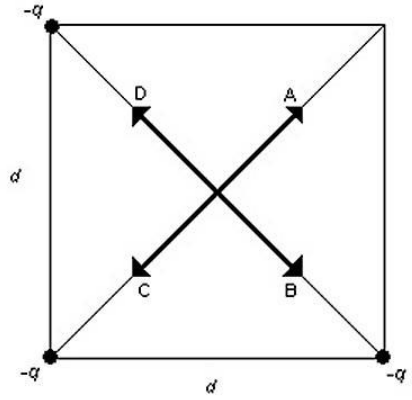
5) Two point charges Q_1 and Q_2 of equal magnitudes and opposite signs are positioned as shown in the figure. Which of the arrows best represents the net electric field at point *P* due to these two charges?



A) A
B) B
C) C
D) D
E) The field is equal to zero at point *P*.

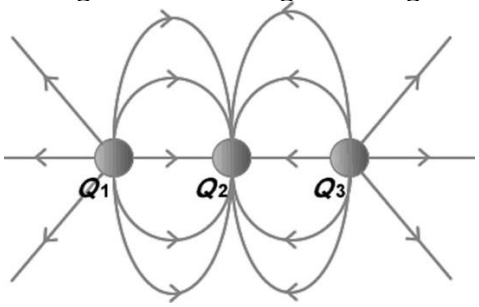
6) Four equal negative point charges are located at the corners of a square, their positions in the *xy*-plane being (1, 1), (-1, 1), (-1, -1), (1, -1). The electric field on the *x*-axis at (1, 0) points in the same direction as
A) $\hat{j}$.
B) $\hat{i}$.
C) $-\hat{i}$.
D) $\hat{k}$.
E) $-\hat{j}$.

7) Three equal negative point charges are placed at three of the corners of a square of side *d* as shown in the figure. Which of the arrows represents the direction of the net electric field at the center of the square?



A) A
B) B
C) C
D) D
E) The field is equal to zero at point *P*.

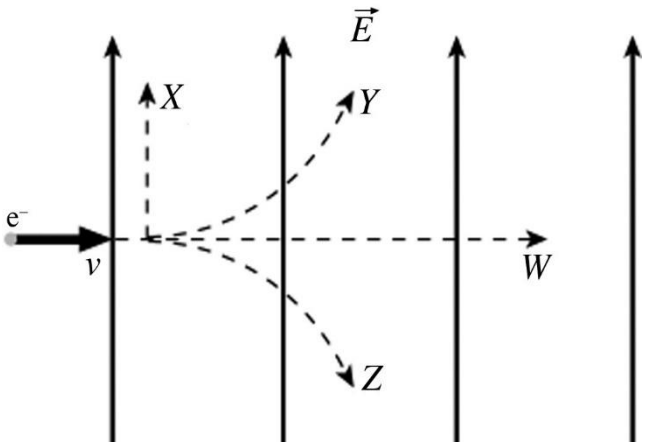
8) The figure shows three electric charges labeled Q_1, Q_2, Q_3, and some electric field lines in the region surrounding the charges. What are the signs of the three charges?



A) Q_1 is positive, Q_2 is negative, Q_3 is positive.
B) Q_1 is negative, Q_2 is positive, Q_3 is negative.
C) Q_1 is positive, Q_2 is positive, Q_3 is negative.
D) All three charges are negative.
E) All three charges are positive.
Answer: A

9) Two large, flat, horizontally oriented plates are parallel to each other, a distance *d* apart. Half way between the two plates the electric field has magnitude *E*. If the separation of the plates is reduced to *d*/2 what is the magnitude of the electric field half way between the plates?
A) 4*E*
B) 2*E*
C) *E*
D) 0
E) *E*/2

10) An electron is initially moving to the right when it enters a uniform electric field directed upwards. Which trajectory shown below will the electron follow?



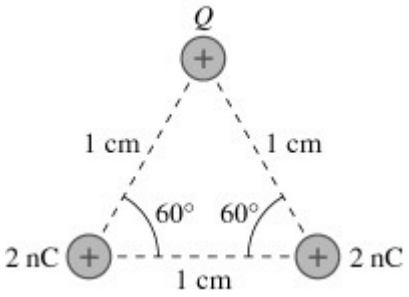
A) trajectory *W*
B) trajectory *X*
C) trajectory *Y*
D) trajectory *Z*
Answer: D

11) A 1.0-C point charge is 15 m from a second point charge, and the electric force on one of them due to the other is 1.0 N. What is the magnitude of the second charge?
($k = 1/4\pi\varepsilon_0 = 8.99 \times 10^9$ N • m^2/C^2)

A) 25 C
B) 1.0 C
C) 10 nC
D) 0.025 C
E) 25 nC
Answer: E

12 A –4.0-μC charge is located 0.45 m to the left of a +6.0-μC charge. What is the magnitude and direction of the electrostatic force on the positive charge?
A) 2.2 N, to the right
B) 2.2 N, to the left
C) 1.1 N, to the right
D) 1.1 N, to the left
E) 4.4 N, to the right
Answer: D

13) In the figure Q = 5.8 nC and all other quantities are accurate to 2 significant figures. What is the magnitude of the force on the charge Q? ($k = 1/4\pi\varepsilon_0 = 8.99 \times 10^9$ N • m^2/C^2)



A) 1.8×10^{-3} N
B) 1.0×10^{-3} N
C) 9.0×10^{-4} N
D) 1.2×10^{-3} N

14) An atomic nucleus has a charge of +40e. What is the magnitude of the electric field at a distance of 1.0 m from the center of the nucleus? ($k = 1/4\pi\varepsilon_0 = 8.99 \times 10^9$ N • m^2/C^2, $e = 1.60 \times 10^{-19}$ C)

A) 5.4×10^{-8} N/C
B) 5.6×10^{-8} N/C
C) 5.8×10^{-8} N/C
D) 6.0×10^{-8} N/C
E) 6.2×10^{-8} N/C

15) The electric field 1.5 cm from a very small charged object points toward the object with a magnitude of 180,000 N/C. What is the charge on the object?
($k = 1/4\pi\varepsilon_0 = 8.99 \times 10^9$ N • m^2/C^2)

A) -4.5 nC
B) +4.5 nC
C) -5.0 nC
D) +5.0 nC

16) A metal sphere of radius 10 cm carries a charge of +2.0 μC uniformly distributed over its surface. What is the magnitude of the electric field due to this sphere at a point 5.0 cm outside the sphere's surface? ($k = 1/4\pi\varepsilon_0 = 8.99 \times 10^9$ N • m^2/C^2)

A) 4.0×10^5 N/C
B) 8.0×10^5 N/C
C) 4.2×10^6 N/C
D) 4.0×10^7 N/C
E) 8.0×10^7 N/C

17) A very long wire carries a uniform linear charge density of $7.0\ \text{nC/m}$. What is the electric field strength $16.0\ \text{m}$ from the center of the wire at a point on the wire's perpendicular bisector? ($\varepsilon_0 = 8.85 \times 10^{-12}\ \text{C}^2/\text{N} \cdot \text{m}^2$)

A) 7.9 N/C
B) 3.9 N/C
C) 0.49 N/C
D) 0.031 N/C

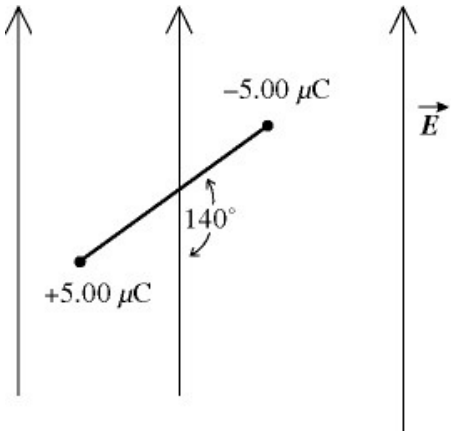
18) A thin, circular disk of radius 30.0 cm is oriented in the *yz*-plane with its center at the origin. The disk carries a total charge of +3.00 μC distributed uniformly over its surface. Calculate the magnitude of the electric field due to the disk at the point $x = 15.0\ \text{cm}$ along the *x*-axis. ($\varepsilon_0 = 8.85 \times 10^{-12}\ \text{C}^2/\text{N} \cdot \text{m}^2$)

A) 9.95×10^5 N/C
B) 4.98×10^5 N/C
C) 3.31×10^5 N/C
D) 2.49×10^5 N/C
E) 1.99×10^5 N/C

19) An electric field is set up between two parallel plates, each of area 2.0 m^2, by putting 1.0 μC of charge on one plate and -1.0 μC of charge on the other. The plates are separated by 4.0 mm with their centers opposite each other, and the charges are distributed uniformly over the surface of the plates. What is the magnitude of the electric field between the plates at a distance of 1.0 mm from the positive plate, but not near the edges of the plates?
($\varepsilon_0 = 8.85 \times 10^{-12}\ \text{C}^2/\text{N} \cdot \text{m}^2$)

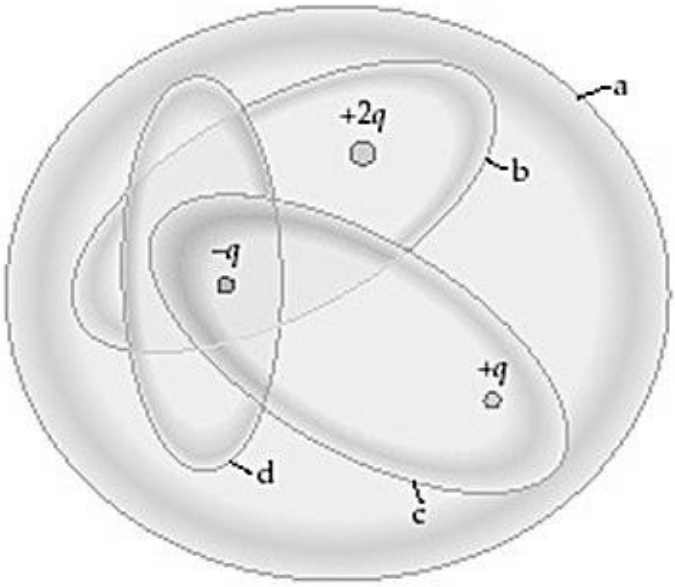
A) 4.2×10^4 N/C
B) 1.4×10^4 N/C
C) 3.1×10^4 N/C
D) 0.00 N/C
E) 5.6×10^4 N/C

20) An electric dipole consists of charges ±5.00 μC separated by 1.20 mm. It is placed in a vertical electric field of magnitude 525 N/C oriented as shown in the figure. The magnitude of the net torque this field exerts on the dipole is closest to



A) 2.02×10^{-6} N • m.
B) 3.15×10^{-6} N • m.
C) 2.41×10^{-6} N • m.
D) 1.01×10^{-6} N • m.
E) 1.21×10^{-6} N • m.
Answer: A

21) The figure shows four Gaussian surfaces surrounding a distribution of charges. Which Gaussian surfaces have an electric flux of $+q/\varepsilon_0$ through them?



22) Referring to the figure in Qs. 21, which Gaussian surfaces have no electric flux through them?

23) Consider a spherical Gaussian surface of radius R centered at the origin. A charge Q is placed inside the sphere. To maximize the magnitude of the flux of the electric field through the Gaussian surface, the charge should be located
A) at $x = 0$, $y = 0$, $z = R/2$.
B) at the origin.
C) at $x = R/2$, $y = 0$, $z = 0$.
D) at $x = 0$, $y = R/2$, $z = 0$.
E) The charge can be located anywhere, since flux does not depend on the position of the charge as long as it is inside the sphere.

24) At a distance D from a very long (essentially infinite) uniform line of charge, the electric field strength is 1000 N/C. At what distance from the line will the field strength to be 2000 N/C?
A) $2D$
B) $\sqrt{2}D$
C) $D/\sqrt{2}$
D) $D/2$
E) $D/4$

25) An uncharged conductor has a hollow cavity inside of it. Within this cavity there is a charge of +10 μC that does not touch the conductor. There are no other charges in the vicinity. Which statement about this conductor is true?
A) The inner surface of the conductor carries a charge of -10 μC and its outer surface carries no excess charge.
B) The inner and outer surfaces of the conductor each contain charges of -5 μC.
C) The net electric field within the material of the conductor points away from the +10 μC charge.
D) The outer surface of the conductor contains +10 μC of charge and the inner surface contains -10 μC.
E) Both surfaces of the conductor carry no excess charge because the conductor is uncharged.

26) A charge $q = 2.00$ μC is placed at the origin in a region where there is already a uniform electric field $\vec{E} = (100 \text{ N/C})\,\hat{i}$. Calculate the flux of the net electric field through a Gaussian sphere of radius $R = 10.0$ cm centered at the origin. ($\varepsilon_0 = 8.85 \times 10^{-12}$ C^2/N • m^2)
A) 5.52×10^5 N • m^2/C
B) 1.13×10^5 N • m^2/C
C) 2.26×10^5 N • m^2/C
D) zero

27) A charge of 1.0×10^{-6} μC is located inside a sphere, 1.25 cm from its center. What is the electric flux through the sphere due to this charge? ($\varepsilon_0 = 8.85 \times 10^{-12}$ C^2/N • m^2)

A) 0.11 N • m^2/C
B) 8.9 N • m^2/C
C) 0.028π N • m^2/C
D) It cannot be determined without knowing the radius of the sphere.

28) A solid nonconducting sphere of radius R carries a uniform charge density throughout its volume. At a radial distance $r_1 = R/4$ from the center, the electric field has a magnitude E_0.

What is the magnitude of the electric field at a radial distance $r_2 = 2R$?

A) $E_0/4$
B) zero
C) $E_0/2$
D) E_0
E) $2E_0$

29) Consider two closely spaced and oppositely charged parallel metal plates. The plates are square with sides of length L and carry charges Q and $-Q$ on their facing surfaces. What is the magnitude of the electric field in the region between the plates?

A) $E = \dfrac{Q}{\varepsilon_0 L^2}$

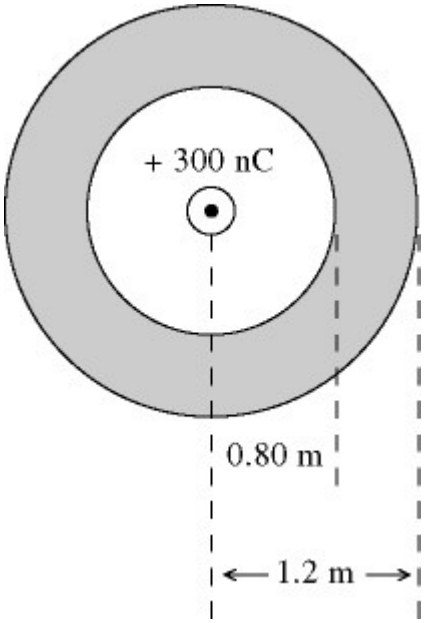
B) $E = \dfrac{2Q}{\varepsilon_0 L^2}$

C) E = 0

D) $E = \dfrac{4Q}{\varepsilon_0 L^2}$

E) $E = \dfrac{Q}{2\varepsilon_0 L^2}$

30) A hollow conducting spherical shell has radii of 0.80 m and 1.20 m, as shown in the figure. The sphere carries an excess charge of -500 nC. A point charge of +300 nC is present at the center. The surface charge density on the inner spherical surface is closest to



A) zero.
B) $+4.0 \times 10^{-8}$ C/m^2.
C) $+6.0 \times 10^{-8}$ C/ m^2.
D) -4.0×10^{-8} C/ m^2.
E) -6.0×10^{-8} C/ m^2.
Answer: D