2021-2022 Spring FIZ1002 Midterm-1

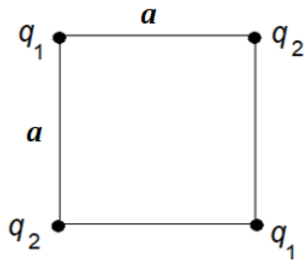
No	A
1.	C
2.	E
3.	A
4.	B
5.	C
6	B
7	D
8.	E
9.	A
10.	C
11	B
12.	E
13.	C

No	A
14.	D
15.	D
16.	A
17.	E
18.	B
19.	C
20.	D
21.	E
22.	A
23.	C
24	D
25	B

A **A** **A**

Name Surname: **Student No:** **Exam Duration: 100 minutes** **18.04.2022**

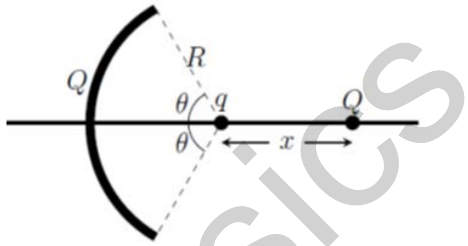
1) As seen in the figure, 4 point charges are placed at the corners of a square with side length of a. To obtain the net electrical force acting on the charge q_2 to be zero, which of the following options define the correct relationship between q_1 and q_2?



a) $q_2 = -\sqrt{2}q_1$ b) $q_2 = \sqrt{2}q_1$ c) $q_2 = -2\sqrt{2}q_1$

d) $q_2 = 2\sqrt{2}q_1$ e) $q_2 = -2q_1$

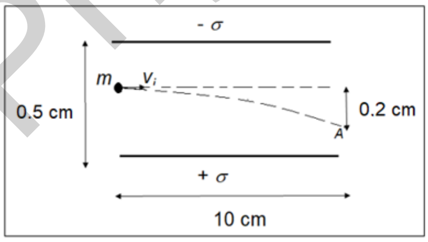
2) A non-conducting rod is shaped as a circular arc of radius R, central angle 2θ. It carries a total charge Q distributed uniformly. A point charge q is located at the center of the circle, while another point charge Q is x distance from the charge q. If the net electric force acting on q is zero, what is x?



a) $x = R\sqrt{\dfrac{\theta}{\cos\theta}}$ b) $x = R^2\sqrt{\dfrac{\sin\theta}{\theta}}$ c) $x = R\sqrt{\dfrac{\cos\theta}{2\theta}}$

d) $x = R^2\sqrt{\dfrac{2\theta}{\sin\theta}}$ e) $x = R\sqrt{\dfrac{\theta}{\sin\theta}}$

The figure shows two thin and large non-conducting sheets of charge in cross-section. The electric field between the sheets is uniform and has a magnitude of 8×10^6 (V/m). Answer the following two questions (3-4) based on this information.



3) What is the surface charge density, σ, of the sheets in $\mu C/m^2$ unit?

a) 72 b) 36 c) 80 d) 144 e) 18

4) A point-charged particle having 5 (g) mass enters this uniform electric field with a v_i velocity as shown in the figure. After t=0.01 (s) the particle leaves the electric field from point A. What is the charge of the particle in nC unit? (Answer the question by ignoring gravitational effects.)

a) 5 b) 25 c) 15 d) 45 e) 30

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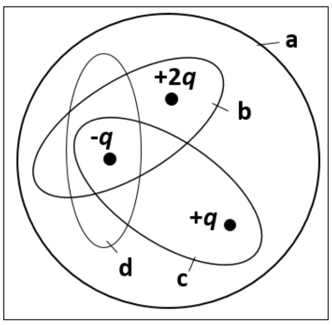
5) Which of the following is **false**?

I) Equipotential lines are perpendicular to the electric field vector.
II) The surface of a conductor is an equipotential surface.
III) The electric field vector points to a higher electric potential.
IV) The electric field inside a conductor in electrostatic equilibrium is zero.
V) An electric dipole in a uniform electric field experiences non-zero electric force.

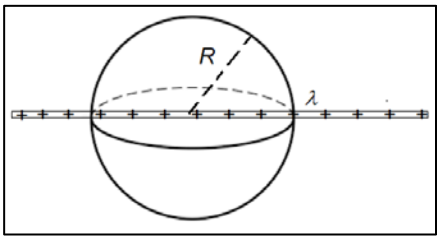
a) I, III, and V b) IV and V c) III and V d) I and III e) II and V

6) The figure shows four Gaussian surfaces (a, b, c, and d) surrounding the distribution of charges. Which Gaussian surface or surfaces have an electric flux of $+\dfrac{q}{\varepsilon_0}$ through them?



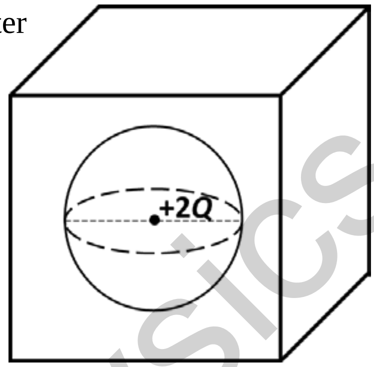
a) a
b) b
c) b and d
d) b and c
e) c

7) The rod in the figure has a uniform λ linear charge density. What is the electric flux through the sphere of radius R whose center is on the rod?



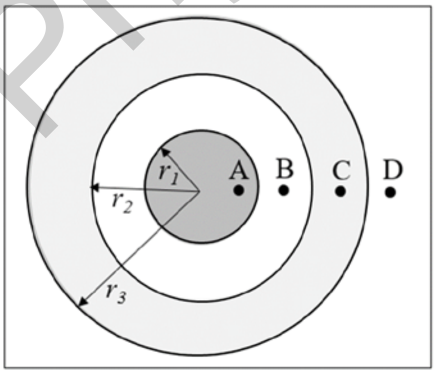
a) $\dfrac{\lambda R}{\varepsilon_0}$ b) $\dfrac{\lambda R}{4\varepsilon_0}$ c) $\dfrac{2\lambda R}{3\varepsilon_0}$ d) $\dfrac{2\lambda R}{\varepsilon_0}$ e) $\dfrac{\lambda}{2R\varepsilon_0}$

8) A conductive cube in electrostatic equilibrium carries a net charge of $+Q$. After placing a point charge of $+2Q$ in the center of a spherical cavity in the cube as in the figure, which of the following options is the correct amount of charge collected on the surface of the spherical cavity and the outer surface of the cube?



a) The charge on the surface of the cavity is -Q and the charge on the outer surface of the cube is -2Q.
b) The charge on the surface of the cavity is +Q and the charge on the outer surface of the cube is +2Q.
c) The charge on the surface of the cavity is -Q and the charge on the outer surface of the cube is +2Q.
d) The charge on the surface of the cavity is +2Q and the charge on the outer surface of the cube is -3Q.
e) The charge on the surface of the cavity is -2Q and the charge on the outer surface of the cube is +3Q.

9) A solid insulating sphere of radius r_1=5 (cm) carries an electric charge Q uniformly distributed throughout its volume. As shown in the figure, concentric with the sphere, a conducting neutral spherical shell is located. The inner and outer radii of the shell are r_2=10 (cm) and r_3=15 (cm), respectively. In which option are the electric field magnitudes in points A (4 (cm) from the center), B (8 (cm) from the center), C (12 (cm) from the center), and D (16 (cm) from the center) shown in the figure ranked correctly from the largest to smallest?



a) A, B, D, C b) B, D, C, A c) D, C, A, B
d) A, D, B, C e) B, A, D, C

An insulating sphere of radius R has a volume charge density that varies with the radius as $\rho = \rho_o \dfrac{r}{a}$ where ρ_o and a are positive constants and r is the distance from the center. The sphere carries $+2Q$. Answer the following two questions (10-11) based on this information.

10) What is the ρ_0 in terms of Q, R, π, and a?

a) $\dfrac{4Qa}{\pi R^3}$ b) $\dfrac{Qa}{\pi R^4}$ c) $\dfrac{2Qa}{\pi R^4}$ d) $\dfrac{2Qa}{\pi R^3}$ e) $\dfrac{Qa}{2\pi R^4}$

11) Which of the following expressions gives the change in the magnitude of the electric field in a sphere with respect to the distance r?

a) $k_e \dfrac{Qr^2}{2R^4}$ b) $2k_e \dfrac{Qr^2}{R^4}$ c) $2k_e \dfrac{Qr^2}{R^3}$ d) $k_e \dfrac{Qr^2}{2R^3}$ e) $2k_e \dfrac{Qr}{R^4}$

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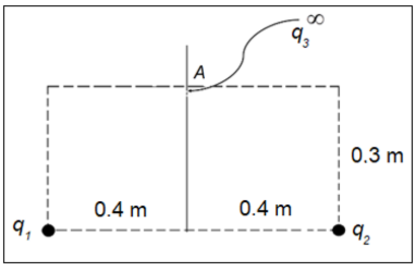
12) The point charges q_1=- $4q$ and q_2=$2q$ are placed at the two corners of a rectangle with a short side of 0.3 (m) and a long side of 0.8 (m), as in the figure. How many nJ is the work required to move the charge q_3=-$2q$ from infinity to point A? (q=1 (nC))



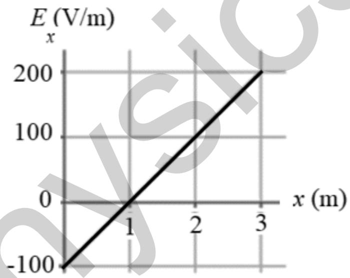
a) 9 b) 18 c) 24 d) 36 e) 72

13) The electrical potential of a point charge Q at a point A with the coordinates of (x, y, z) which is r away from the point charge is defined by $k_e \frac{Q}{r}$. What is the magnitude of the z-component of the electric field at a distance r from the point charge?

a) $\frac{z^2 k_e Q}{\left(x^2+y^2+z^2\right)^{1/2}}$ b) $-\frac{k_e Q}{z\left(x^2+y^2+z^2\right)^{3/2}}$ c) $\frac{k_e Q z}{\left(x^2+y^2+z^2\right)^{3/2}}$

d) $-\frac{k_e Q z}{\left(x^2+y^2+z^2\right)^{3/2}}$ e) $-\frac{2k_e Q z}{\left(x^2+y^2+z^2\right)^{1/2}}$

14) The figure shows the x-component of an electric field (E_x(V/m)) as a function of coordinate of x in (m). The electric potential at the origin is -50 (V). What is the electric potential at x=3 (m)?



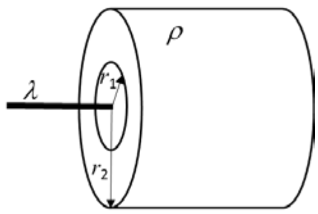
a) 0 b) 150 (V) c) -150 (V) d) -200 (V) e) 200 (V)

15) In a certain region of space, a uniform electric field is in the +x-direction. A particle with a negative charge is moved from x=20 (cm) to x=60 (cm). Which of the following statements is correct?

I) The potential energy of the particle increases.
II) The potential energy of the particle decreases.
III) The particle moves to a region of the lower electric potential.
IV) The particle moves to a region of the higher electric potential.
V) The kinetic energy of the particle increases.
VI) The kinetic energy of the particle decreases.

a) I, III, and V b) II, IV, and VI c) I, IV, and V d) I, III, and VI e) II, IV, and V

A very long line charge distribution with uniform linear charge density λ is surrounded by a concentric cylindrical tube of inner radius r_1 and outer radius r_2, containing uniform volume charge density ρ. The electric field outside the tube ($r > r_2$) is zero. Answer the following two questions (16-17) based on this information.



16) What is the relation between λ and ρ?

a) $\lambda+\rho\pi\left(r_2^2-r_1^2\right)=0$ b) $\lambda+\rho\pi\left(r_2^2-r^2\right)=0$ c) $\lambda r_1+\rho\pi\left(r_2-r_1\right)^2=0$

d) $\lambda\left(r_2-r_1\right)+\rho\pi\left(r_2{}^2-r_1{}^2\right)=0$ e) $\lambda+\frac{4}{3}\pi\rho\left(r_2{}^3-r_1{}^3\right)=0$

17) What is the potential difference $V(r_2)$-$V(r_1)$?

a) 0 b) $\frac{\rho}{4\varepsilon_0}\left[\frac{\left(r_2-r_1\right)^2}{2}+r_2^2\ln\left(\frac{r_2}{r_1}\right)\right]$ c) $\frac{\rho}{2\varepsilon_0}\left[\frac{\left(r_2-r_1\right)^2}{2}+r_2^2\ln\left(\frac{r_2}{r_1}\right)\right]$

d) $\frac{\rho}{2\varepsilon_0}\left[\frac{\left(r_1-r_2\right)^2}{2}+r_1^2\ln\left(\frac{r_2}{r_1}\right)\right]$ e) $\frac{\rho}{2\varepsilon_0}\left[\frac{r_1^2}{2}-\frac{r_2^2}{2}+r_2^2\ln\left(\frac{r_2}{r_1}\right)\right]$

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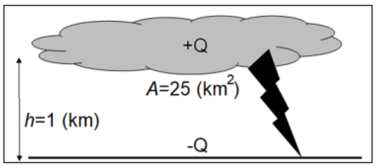
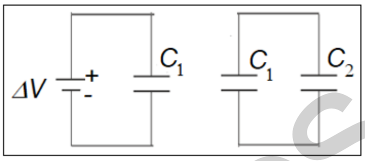
18) A rain cloud and the ground can be thought of as a parallel plate capacitor with air between its plates, as in the figure. In order for lightning to flash, there must be an electric field of approximately 1 (kV/cm) in the air. Accordingly, how much charge should a rain cloud which is 1 (km) above the ground and has a surface area of approximately 25 (km^2) accumulate to lightning flash?



a) 225 (C) b) 22.5 (C) c) 225 (mC) d) 22.5 (μC) e) 2250 (C)

The capacitor having capacitance of C_1=6 (μF) is first charged with a potential difference of ΔV=50 (V) as in the first figure. Then the C_1 capacitor is connected to the uncharged C_2=3 (μF) capacitor as in the second figure. Answer the following two questions (19-20) based on this information.



19) Which option is given correctly the final charges of both capacitors (Q_1, Q_2) in terms of (μC)?

a) 100, 200 b) 50, 150 c) 200, 100 d) 150, 50 e) 125, 175

20) What is the energy change, ΔU, stored in the capacitor C_1 in J unit?

a) 125×10^{-4} b) $\dfrac{125}{2}\times10^{-4}$ c) $\dfrac{125}{4}\times10^{-4}$ d) $\dfrac{125}{3}\times10^{-4}$ e) $\dfrac{125}{5}\times10^{-4}$

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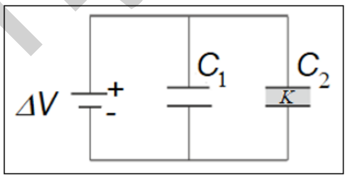
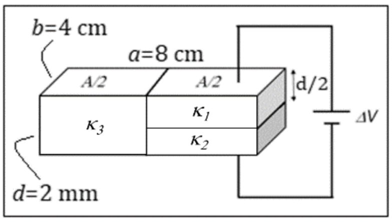
21) Initially, the parallel plate capacitors C_1 and C_2 having equal capacitances are connected to a battery that gives a potential difference of ΔV= 10 (V). Then a dielectric slab with a dielectric constant of K=3 is inserted between the plates of C_2 capacitor, as shown. The electrical potential energy of the system is expressed as U_0 while U denotes the electrical potential energy of the system when the dielectric slab is used. What is the ratio of U_0/U?



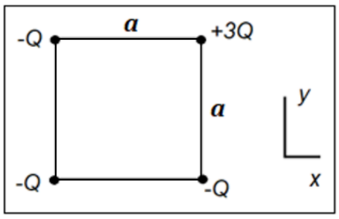
a) 4 b) 1/3 c) 3 d) 1/2 e) 2

22) A rectangular parallel plate capacitor having sides a and b and separation d is filled with three different dielectric materials as shown in the figure. What is the equivalent capacitance of the device in (F) unit?
(K_1=2, K_2=4, and K_3= 5)



a) 552×10^{-13} b) 288×10^{-13} c) 576×10^{-13} d) 360×10^{-13} e) 192×10^{-13}

Four charges are kept at the corners of a square with the edge of a. Three charges are $-Q$ and one is $+3Q$. Answer the following two questions (23-24) based on this information. ($\sin 45^\circ = \cos 45^\circ = \sqrt{2}/2$)



23) What is the net electric dipole moment vector of this system?

a) $\sqrt{2}Qa\left(-\hat{i}+\hat{j}\right)$ b) $\dfrac{\sqrt{2}}{2}Qa\left(-\hat{i}+\hat{j}\right)$ c) $2Qa\left(\hat{i}+\hat{j}\right)$ d) $-2Qa\left(\hat{i}+\hat{j}\right)$ e) $\sqrt{2}Qa\left(\hat{i}-\hat{j}\right)$

24) If this point charge system is located in a uniform E_o electric field which is directed along the negative y-axis, what is the net torque acting on this system?

a) $\sqrt{2}QaE_o\hat{k}$ b) $-2QaE_o\hat{j}$ c) $-\dfrac{\sqrt{2}}{2}QaE_o\hat{k}$ d) $-2QaE_o\hat{k}$ e) $-2QaE_o\hat{i}$

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25) A point charge is placed at the center of an imaginary cube with an edge length of 20 (cm). The electric flux passing through one square surface of the cube is -3 (kNm^2/C). What is the charge at the center of the cube in (nC) unit?

a) -27 b) -162 c) -54 d) -118 e) -36