YTU Physics Department 2024-2025 Spring Semester			
FIZ1002 Physics-2 Mid Term-1			
Question Sheet	**AAAAAA**	**07.04.2025 14.00-15.40**	**100 m**

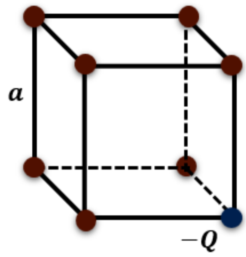
Name		The 9th article of Student Disciplinary Regulations of YÖK Law No.2547 states "**Cheating or helping to cheat or attempt to cheat in exams**" de facto perpetrators take **one or two semesters suspension** penalty. Students are NOT permitted to bring **calculators, mobile phones, smart watches** and/or any other unauthorized **electronic devices** into the exam room.
Surname		
Student No		
Group/Saloon		
Signature		

θ	0^0	30^0	37^0	45^0	53^0	60^0	90^0
sin	0	1/2	3/5	$\sqrt{2}/2$	4/5	$\sqrt{3}/2$	1
cos	1	$\sqrt{3}/2$	4/5	$\sqrt{2}/2$	3/5	1/2	0

$k = 1/(4\pi\varepsilon_0) \cong 9\,10^9 \frac{Nm^2}{C^2}$
$\varepsilon_0 \cong 9\,10^{-12} F/m$
$q = q_e = q_p = 1.6\,10^{-19} C$
$g = 10\frac{m}{s^2}, \pi = 3$

$\vec{F} = k\frac{q_1q_2}{r^2}\hat{r}$; $\vec{E} = k\frac{q}{r^2}\hat{r}$; $\vec{E} = k\int\frac{dq}{r^2}\hat{r}$; $V = k\frac{q}{r}$; $V = k\int\frac{dq}{r}$; $V(\infty) = 0$; $\Delta U = q\Delta V$; $dV = 4\pi r^2 dr$; $dV = 2\pi l r dr$;
$\lambda = \frac{Q}{L} = \frac{dq}{dl}$; $\sigma = \frac{Q}{A} = \frac{dq}{dA}$; $\rho = \frac{Q}{V} = \frac{dq}{dV}$; $\phi_E = \int\vec{E}.d\vec{A}$; $V_B - V_A = -\int_A^B \vec{E}.d\vec{l}$; $\oint\vec{E}.d\vec{A} = \frac{Q_{in}}{\varepsilon_0}$; $|\Delta V| = Ed$; $E_i = \frac{\sigma}{2\varepsilon_0}$;
$E_c = \frac{\sigma}{\varepsilon_0}$; $p = aq$; $\vec{\tau} = \vec{p}\times\vec{E}$; $U = -\vec{p}.\vec{E}$; $\vec{E} = -\frac{\partial V(x,y,z)}{\partial x}\hat{\imath} - \frac{\partial V(x,y,z)}{\partial y}\hat{\jmath} - \frac{\partial V(x,y,z)}{\partial z}\hat{k}$; $C = \frac{|Q|}{|\Delta V|}$; $C = \frac{\varepsilon_0 A}{d}$; $U = \frac{1}{2}CV^2$;
$\frac{1}{C_{eq}} = \sum_i \frac{1}{C_i}$; $C_{eq} = \sum_i C_i$; $C = \kappa C_0$; $V = \frac{V_0}{\kappa}$ $E = \frac{E_0}{\kappa}$; $U = \frac{U_0}{\kappa}$; $W = \int\vec{F}.d\vec{r}$; $W = -\Delta U$; $U = \frac{1}{2}\sum_{i\neq j} k\frac{q_iq_j}{r_{ij}}$; $I = \frac{dq}{dt}$;
$I = nqv_dA$; $R = \rho\frac{\ell}{A}$; $\vec{J} = \sigma\vec{E}$; $R = \frac{\Delta V}{I}$; $\sigma = \frac{1}{\rho}$; $J = \frac{I}{A}$; $P = I^2R$; $\vec{a} = \frac{d\vec{v}}{dt}$; $\vec{v} = \vec{v_0} + \vec{a}t$; $\vec{r} = \vec{r_0} + \vec{v_0}t + \frac{1}{2}\vec{a}t^2$

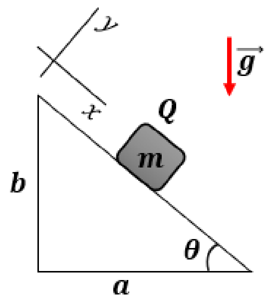
1) What is the net electric potential at the center of a cube with side length a, where seven corners have a charge of $+Q$ and one corner has a charge of $-Q$, expressed in terms of kQ/a?



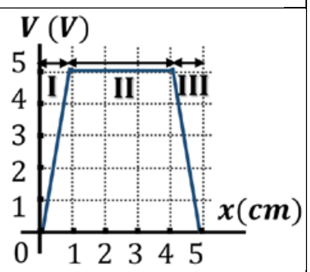
A) $8/\sqrt{3}$ B) $\sqrt{3}/2$ C) $4/\sqrt{2}$ D) $4/\sqrt{3}$ E) $12/\sqrt{3}$

2) What is the electric field vector required to keep a mass m with charge +Q stationary on a frictionless, insulated inclined plane?

A) $-\left(\frac{mgb}{Q\sqrt{a^2+b^2}}\right)\hat{\imath}$ B) $\left(\frac{mgb}{Qa}\right)(-\hat{\imath}+\hat{\jmath})$ C) $\left(\frac{mgb}{Q\sqrt{a^2+b^2}}\right)(\hat{\imath}+\hat{\jmath})$ D) $\left(\frac{mgb}{Qa}\right)\hat{\imath}$ E) $-\left(\frac{mgab}{Q\sqrt{a+b}}\right)\hat{\imath}$

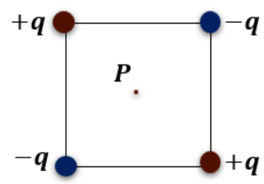


3) A graph showing the relationship between potential and position for a certain region with an electric field is given in the figure. Which of the following options is the ranking of the electric field vectors in regions I, II, and III correctly given in V/cm?



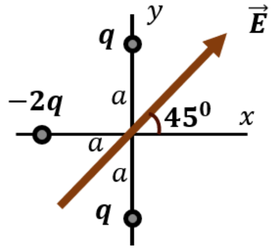
A) $5\hat{\imath}, 0, -5\hat{\imath}$ B) $-5\hat{\imath}, 0, 5\hat{\imath}$ C) $2\hat{\imath}, 0, -2\hat{\imath}$ D) $0, 5\hat{\imath}, 0$ E) $-\hat{\imath}, 5\hat{\imath}, \hat{\imath}$

4) What is the work done to bring four point charges from infinity to the corners of a square with side length a as shown in the figure, expressed in terms of kq^2/a?



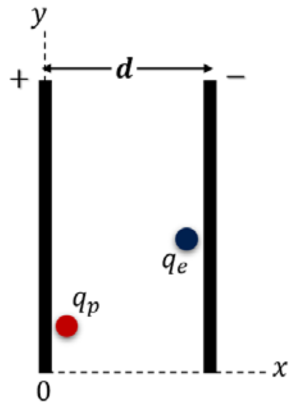
A) $(\sqrt{2}-2)$ B) $(\sqrt{2}-4)$ C) $\left(1+\frac{1}{\sqrt{2}}\right)$ D) $\left(2-\frac{2}{\sqrt{2}}\right)$ E) $(\sqrt{2}-8)$

5) Three-point charges are placed in a uniform electric field within the x-y coordinate system. What is the torque acting on the total electric dipole moment created by the system? $E = 2\ N/C$ (Neglect the electric fields caused by the point charges themselves).



A) $4\sqrt{2}\ qa\ \hat{k}$ B) $4/\sqrt{2}\ qa\ \hat{\imath}$ C) $-2\sqrt{2}\ qa\ \hat{\imath}$ D) $2\sqrt{2}\ qa\ \hat{k}$ E) $-4/\sqrt{2}\ qa\ \hat{k}$

6) Two parallel metal plates are placed 10 cm apart, and a 100 V potential difference is applied to create a uniform electric field between them. A proton is released from the positive plate, and an electron is released from the negative plate simultaneously with zero initial velocity. When the proton and electron align along the x-axis, which expression correctly gives the proton's distance from the positive plate? (Neglect the forces that both point charges exert on each other).

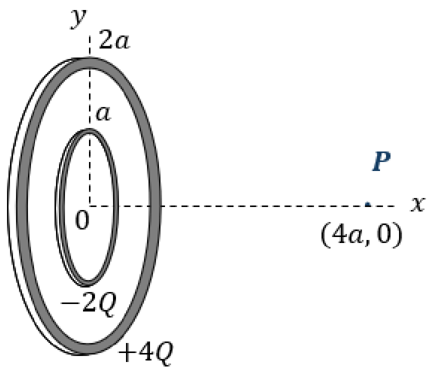


A) $\frac{m_p d}{(m_e+m_p)}$ B) $\frac{m_e d}{2(m_e+m_p)}$ C) $\frac{m_p d}{2(m_e+m_p)}$ D) $\frac{m_e 2d}{(m_e+m_p)}$ E) $\frac{m_e d}{m_e+m_p}$

Sorular 7-8) A ring with radius a and charge $-2Q$ is placed inside another ring with radius $2a$ and charge $+4Q$, as shown in the figure. Point P is located at a distance of $4a$ from the center of the rings along the x-axis, perpendicular to their plane.

7) What is the electric potential at $P(4a, 0)$ in terms of $\frac{kQ}{a}$?

A) $\frac{4}{\sqrt{20}}+\frac{2}{\sqrt{17}}$ B) $\frac{4}{\sqrt{6}}-\frac{2}{\sqrt{5}}$ C) $\frac{4}{\sqrt{20}}-\frac{2}{\sqrt{17}}$ D) $\frac{4}{\sqrt{6}}+\frac{2}{\sqrt{5}}$ E) $-\frac{4}{\sqrt{6}}+\frac{2}{\sqrt{5}}$



8) What is the electric field vector at $P(4a, 0)$ in terms of $\frac{kQ}{a^2}$?

A) $\frac{16}{(\sqrt{20})^3}-\frac{8}{(\sqrt{17})^3}\hat{\imath}$ B) $-\frac{16}{(\sqrt{20})^3}+\frac{8}{(\sqrt{17})^3}\hat{\imath}$ C) $\frac{16}{(\sqrt{6})^3}-\frac{4}{(\sqrt{5})^3}\hat{\imath}$ D) $\frac{16}{(\sqrt{6})^3}+\frac{4}{(\sqrt{5})^3}\hat{\imath}$ E) $\frac{16}{(\sqrt{6})^3}-\frac{8}{(\sqrt{5})^3}\hat{\imath}$

Sorular 9-10) The volume charge density of an infinitely long insulating cylinder with radius R is given by $\rho = 3\rho_0 r$. ρ_0 is a positive constant, and r is the radial distance from the center of the cylinder.

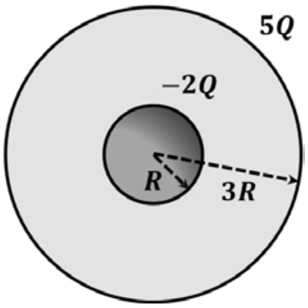
9) What is the electric field intensity inside the cylinder for $r < R$?

A) $\frac{\rho_0 r}{6\varepsilon_0}$ B) $\frac{\rho_0 r^2}{6\varepsilon_0}$ C) $\frac{3\rho_0 r}{4\varepsilon_0}$ D) $\frac{\rho_0 r^2}{\varepsilon_0}$ E) $\frac{3\rho_0 r^2}{2\varepsilon_0}$

10) What is the electric field intensity outside the cylinder for $r > R$?

A) $\frac{\rho_0 R^2}{6\varepsilon_0}$ B) $\frac{\rho_0 R^3}{6\varepsilon_0 r}$ C) $\frac{3\rho_0 R^2}{4\varepsilon_0}$ D) $\frac{\rho_0 R^3}{\varepsilon_0 r}$ E) $\frac{3\rho_0 R^3}{2\varepsilon_0 r}$

Sorular 11-14) A homogeneous insulating sphere of charge $-2Q$ and radius R is positioned at the center of an electrostatically balanced conducting sphere of radius $3R$, as shown in the figure. The conducting sphere has a total charge of $5Q$.



11) What are the electric field vectors at $r = 2R$ and $r = 4R$?

A) $E_{2R} = 0; E_{4R} = \frac{7kQ}{16R^2}\hat{r}$ B) $E_{2R} = -\frac{2kQ}{R^2}\hat{r}; E_{4R} = \frac{5kQ}{16R^2}\hat{r}$ C) $E_{2R} = 0; E_{4R} = \frac{3kQ}{16R^2}\hat{r}$
D) $E_{2R} = 0; E_{4R} = \frac{5kQ}{16R^2}\hat{r}$ E) $E_{2R} = -\frac{2kQ}{R^2}\hat{r}; E_{4R} = \frac{3kQ}{16R^2}\hat{r}$

12) What is the charge density on the outer surface of the conducting sphere?

A) $\frac{5Q}{36\pi R^2}$ B) $\frac{3Q}{12\pi R^2}$ C) $\frac{Q}{12\pi R^2}$ D) $\frac{3Q}{18\pi R^2}$ E) $\frac{Q}{3\pi R^2}$

13) What is the net electric flux passing through the conducting sphere's surface?

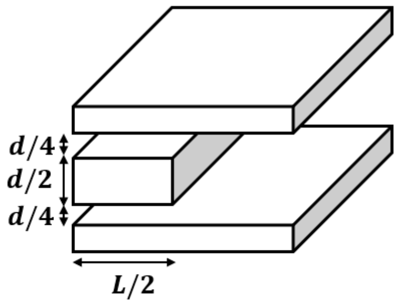
A) $\frac{3Q}{\varepsilon_0}$ B) $\frac{5Q}{\varepsilon_0}$ C) $\frac{7Q}{\varepsilon_0}$ D) $\frac{5Q}{2\varepsilon_0}$ E) $\frac{3Q}{2\varepsilon_0}$

14) What is the electric potential at a point on the outer surface of the conducting sphere?

A) $\frac{3Q}{16\pi\varepsilon_0 R}$ B) $\frac{3Q}{4\pi\varepsilon_0 R}$ C) $\frac{5Q}{12\pi\varepsilon_0 R}$ D) $\frac{7Q}{12\pi\varepsilon_0 R}$ E) $\frac{Q}{4\pi\varepsilon_0 R}$

Sorular 15-16) A parallel plate capacitor is constructed using square-shaped conductive plates with side length $L = 4\ cm$ and separation $d = 1.6\ cm$. A potential difference of $2\ V$ is applied between the plates.

15) If a conductive layer with thickness $d/2$, width $L/2$, and length L is inserted between the capacitor plates as shown in the figure, what is the new capacitance of the capacitor?



A) $135\ 10^{-12}\ F$ B) $2.7010^{-12}\ F$ C) $270\ 10^{-12}\ F$ D) $1.35\ 10^{-12}\ F$ E) $141\ 10^{-12}\ F$

16) How much energy does the capacitor store in joules?

A) $1.35\ 10^{-12}$ B) $2.7\ 10^{-10}$ C) $5.4\ 10^{-12}$ D) $2.7\ 10^{-12}$ E) $2.82\ 10^{-10}$

Sorular 17-19) A copper conductor with a length of $0.6\ m$ and a diameter of $0.2\ mm$ is placed along the x-axis between $x = 0$ and $x = 0.6\ m$ with a potential difference of 2.4 V ($\rho_{Cu} = 2\ 10^{-8}\Omega m$).

17) What is the resistance of the wire in Ω?

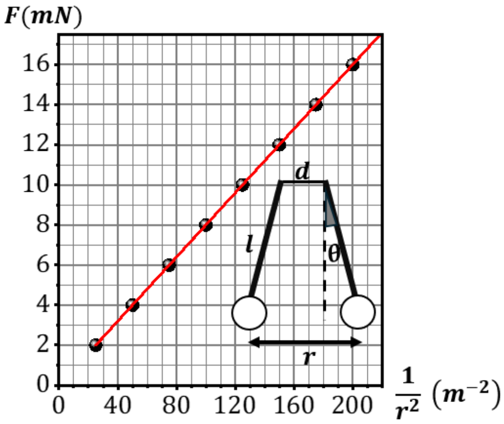
A) 6 B) 0.3 C) 3 D) 4 E) 0.4

18) What is the current flowing through the wire in A?

A) 0.8 B) 8 C) 6 D) 0.6 E) 0.4

19) What is the current density in A/m^2?

A) $0.2\ 10^8$ B) $3\ 10^8$ C) $2\ 10^8$ D) $0.3\ 10^6$ E) $1.5\ 10^6$



20) Experiment question

A physicist attempting to determine Coulomb's constant sets up the experimental setup shown in the figure using identical spheres and insulating strings of different lengths. Each sphere is charged with $+100\ nC$, and after reaching equilibrium, the angles θ between the strings and the vertical axis are measured to calculate the electrostatic force between the spheres. Given the distance r between the centers of the spheres, the physicist obtains the graph $F = f\left(\frac{1}{r^2}\right)$. What value of Coulomb's constant does the physicist find in Nm^2/C^2?

A) $8\ 10^9$ B) $9\ 10^9$ C) $6\ 10^9$ D) $8\ 10^6$ E) $9\ 10^6$