YTU Physics Department, 2025-2026 Spring Semester			
FIZ1002 Physics-2 Midterm Exam-1			
Question Sheet	A	13.04.2026 14.00-15.50	110 min

Name			Under Article 9 of the Student Disciplinary Regulation of Law No. 2547 of the Council of Higher Education (YÖK), students who commit or attempt to commit the act of cheating in examinations, or assisting others in cheating, shall be subject to suspension for one or two semesters. Students are strictly prohibited from bringing calculators, mobile phones, smart watches, and/or any electronic devices into the examination room.
Surname			
Std. Number			
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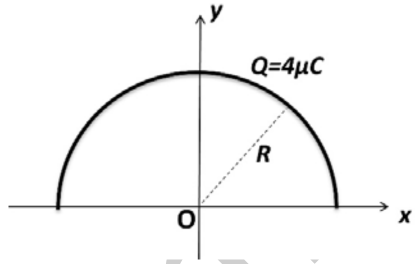
Student Signature			

Q1-2) A total charge of +4 μC is uniformly distributed along a thin wire bent into a semicircle of radius 10 cm.

Q1) Calculate the magnitude of the electric field vector at point O, which is located on the x-axis and is the center of the semicircle.

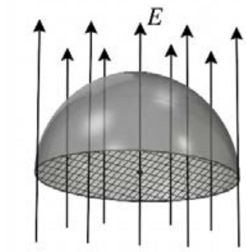


A) 8×10^5 N/C B) 12×10^5 N/C C) 16×10^5 N/C D) 20×10^5 N/C E) 24×10^5 N/C

Q2) When a point charge of $+0.2\ \mu C$ is brought from infinity to point O, calculate the change in its electric potential energy. $(V(\infty) = 0)$

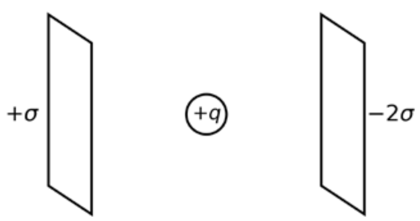
A) 2.4×10^{-2} J B) 4.8×10^{-2} J C) 6×10^{-2} J D) 7.2×10^{-2} J E) 9.6×10^{-2} J

Q3) A hemisphere of radius R is placed in a uniform electric field $\vec{E}$. The flat circular face of the hemisphere is perpendicular to the direction of the electric field. Determine the electric flux through the curved (dome-shaped) surface of the hemisphere.



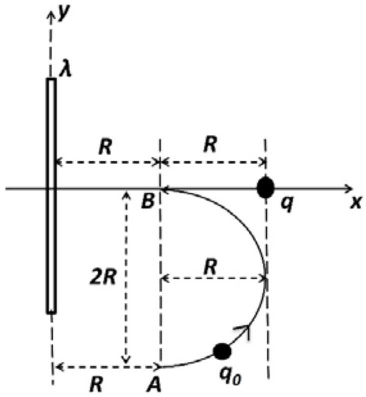
A) $4\pi ER^2$ B) $2\pi ER^2$ C) πER^2 D) $\frac{1}{2}\pi ER^2$ E) $\frac{1}{4}\pi ER^2$

Q4) Two infinitely large parallel plane sheets carry surface charge densities of +σ and −2σ, respectively. A particle with charge +q and mass m, located in the region between the sheets, starts moving in the direction of the electric field with an initial speed v_0. Determine its speed after it has traveled a distance d in the uniform electric field.



A) $v = \sqrt{v_0^2 + \frac{3q\sigma d}{m\varepsilon_0}}$ B) $v = \sqrt{v_0^2 + \frac{3q\sigma d}{2m\varepsilon_0}}$ C) $v = \sqrt{v_0^2 + \frac{2q\sigma d}{m\varepsilon_0}}$ D) $v = \sqrt{v_0^2 + \frac{q\sigma d}{2m\varepsilon_0}}$ E) $v = \sqrt{v_0^2 + \frac{q\sigma d}{m\varepsilon_0}}$

Q5-6) A thin wire, assumed to be infinitely long and having a linear charge density of +λ, and a point charge of +q are arranged as shown in the figure. The distances from the wire to points A and B are R, the distance between point B and the +q charge is R, and the vertical distance between points A and B is 2R.



Q5) Determine the work required to move the test charge $+q_0$ from point A to point B at constant speed along the semicircular path of radius R shown in the figure.

A) $kq_0\left[2\lambda \ln R + \frac{q}{R}\left(\frac{\sqrt{5}-1}{\sqrt{5}}\right)\right]$ B) $kq_0q\left(\frac{1+\sqrt{5}}{R\sqrt{5}}\right)$ C) $kq_0\left(\frac{\sqrt{5}-1}{R\sqrt{5}}\right)(\lambda R - q)$

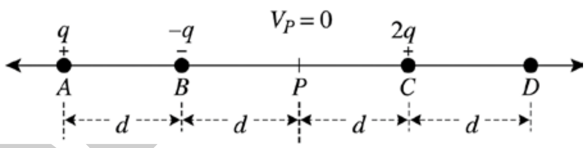
D) $\frac{kq_0}{R}\left[2\lambda R + q\left(\frac{1-\sqrt{5}}{\sqrt{5}}\right)\right]$ E) $kq_0q\left(\frac{\sqrt{5}-1}{R\sqrt{5}}\right)$

Q6) Determine the net force acting on the test charge $+q_0$ at point B.

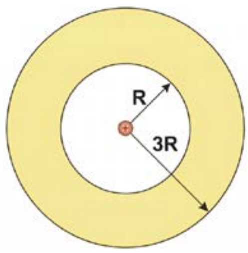
A) $\frac{k\,q_0}{R^2}(2\lambda R - q)\hat{\imath}$ N B) $\frac{k\,q_0}{R^2}(2\lambda R + q)\hat{\imath}$ N C) $\frac{k\,q_0}{R^2}(\lambda R - q)\hat{\imath}$ N D) $\frac{2k\,q_0}{R^2}(\lambda R - q)\hat{\imath}$ N E) $\frac{k\,q_0}{R}(2\lambda R - q)\hat{\imath}$ N

Q7) As shown in the figure, point charges are placed along a straight line at points A, B, C, and D. The charges at A, B, and C are +q, −q, and +2q, respectively. Given that the total electric potential at point P is zero, calculate the charge at point D.

A) $-q$ B) $-2q$ C) $+3q$ D) $-3q$ E) $+2q$



Q8-9) A spherical conductor of radius 3R carries a total charge of +3Q and contains a spherical cavity of radius R at its center. A point charge of +Q is placed at the exact center of this cavity.



Q8) Determine which of the following correctly gives the electric field vectors at points located at distances; $r = \frac{R}{2}$, $r = 2R$ ve $r = 4R$ from the center, respectively.

A) $\vec{E}_{R/2} = \frac{2kQ}{R^2}\hat{r};\ \vec{E}_{2R} = 0;\ \vec{E}_{4R} = \frac{kQ}{4R^2}\hat{r}$

B) $\vec{E}_{R/2} = \frac{kQ}{R^2}\hat{r};\ \vec{E}_{2R} = 0;\ \vec{E}_{4R} = \frac{kQ}{4R^2}\hat{r}$

C) $\vec{E}_{R/2} = \frac{4kQ}{R^2}\hat{r};\ \vec{E}_{2R} = 0;\ \vec{E}_{4R} = \frac{kQ}{4R^2}\hat{r}$

D) $\vec{E}_{R/2} = \frac{4kQ}{R^2}\hat{r};\ \vec{E}_{2R} = \frac{kQ}{4R^2}\hat{r};\ \vec{E}_{4R} = \frac{kQ}{4R^2}\hat{r}$

E) $\vec{E}_{R/2} = \frac{4kQ}{R^2}\hat{r};\ \vec{E}_{2R} = 0;\ \vec{E}_{4R} = \frac{4kQ}{R^2}\hat{r}$

Q9) Calculate the surface charge density on the outer surface of the conductor.

A) $\frac{Q}{3\pi R^2}$ B) $\frac{Q}{9\pi R^2}$ C) $\frac{Q}{18\pi R^2}$ D) $\frac{Q}{12\pi R^2}$ E) $\frac{Q}{36\pi R^2}$

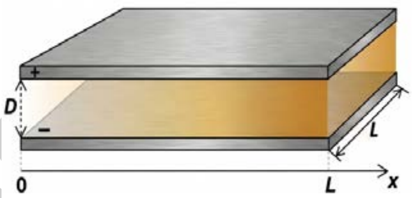
Q10) In a region of space, the electric potential is given by $V(x,y,z) = Ax^2y^2 - Byz^2 + 4\ V$.
Here, A = 1 V/m⁴ and B = 1 V/m³, and the position variables x, y, and z are expressed in meters (m). Determine the electric field vector at point P(1, 2, 3).

A) $(-8\hat{\imath} + 15\hat{\jmath} + 3\hat{k})$ N/C B) $(-4\hat{\imath} + 5\hat{\jmath} + 6\hat{k})$ N/C C) $(-10\hat{\imath} + 3\hat{\jmath} + 12\hat{k})$ N/C
D) $(-8\hat{\imath} + 5\hat{\jmath} + 12\hat{k})$ N/C E) $(-10\hat{\imath} + 15\hat{\jmath} + 3\hat{k})$ N/C

Q11) A spherical capacitor with an initial capacitance C_0 and charge Q is disconnected from the source. Then, a dielectric material with dielectric constant κ is inserted so as to completely fill the space between the inner and outer conducting shells. Determine the change in the energy stored in the capacitor.

A) $\Delta U = \frac{Q^2(1-\kappa)}{2\kappa C_0}$ B) $\Delta U = \frac{Q^2(1-\kappa)}{\kappa C_0}$ C) $\Delta U = \frac{Q^2}{2\kappa C_0}$ D) $\Delta U = \frac{Q^2(1-\kappa)}{2C_0}$ E) $\Delta U = \frac{Q^2(\kappa-1)}{2C_0}$

Q12) A capacitor consists of two parallel square plates, length L, separated by a distance D.
The space between the plates is filled with a dielectric material whose dielectric constant varies as $\kappa(x) = a + \frac{bx}{L}$ for $(0 \le x \le L)$, where $(a > 1, b > 0)$. Determine the capacitance of this capacitor.



A) $C = \frac{\varepsilon_0 L^2}{D}\left(\frac{a}{2}+b\right)$ B) $C = \frac{\varepsilon_0 L^2}{D}(a+b)$ C) $C = \frac{\varepsilon_0 L^2}{D}\left(a+\frac{b}{2}\right)$ D) $C = \frac{\varepsilon_0 L^2}{D}\left(a-\frac{b}{2}\right)$ E) $C = \frac{\varepsilon_0 L^2}{2D}(a+b)$

Q13) Calculate the current passing through a conducting copper wire of length 6 m and diameter 0.2 mm if the potential difference between its ends is 3.4 V. $(\rho_{Cu} = 1.7\ 10^{-8}\Omega m)$

A) 1.00 A B) 0.50 A C) 0.75 A D) 0.25 A E) 1.5 A

Q14) A uniform wire initially dissipates 100 W of power. The wire is stretched and made thinner so that its length becomes n times its original length, while its volume remains constant. If the voltage applied across the ends of the wire remains unchanged, determine its new power dissipation.

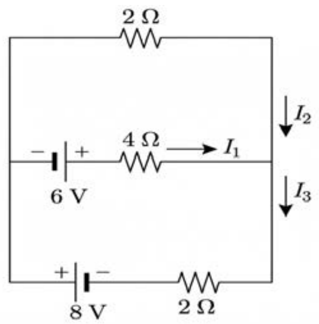
A) $\frac{100}{n}$ W B) $\frac{100}{n^2}$ W C) 100n W D) 100n² W E) 100 W

Q15: Which of the following statements is **incorrect** for a charged conductor in electrostatic equilibrium?

I. The electric field inside the conductor is zero.
II. The net charge on the conductor resides on its surface.
III. The surface of the conductor is an equipotential surface.
IV. The electric field just outside the conductor is perpendicular to the surface.
V. The surface charge density of the conductor is smallest at the point where the radius of curvature is the smallest (sharp point).

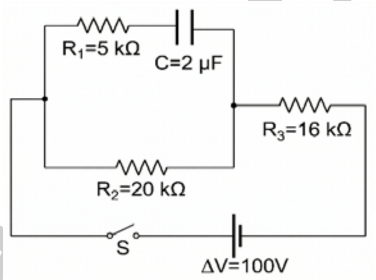
A) I B) II C) III D) IV E) V

Q16) Calculate the values of the currents I_1, I_2, and I_3 in the circuit shown in the figure.



A) $I_1 = 1.5\,A,\ I_2 = 1.5\,A,\ I_3 = 3\,A$
B) $I_1 = 2\,A,\ I_2 = 0.5\,A,\ I_3 = 2.5\,A$
C) $I_1 = 1\,A,\ I_2 = 1\,A,\ I_3 = 2\,A$
D) $I_1 = 2\,A,\ I_2 = 1\,A,\ I_3 = 3\,A$
E) $I_1 = 3\,A,\ I_2 = 1\,A,\ I_3 = 4\,A$

Q17-18) In the circuit shown in the figure, the capacitor is initially uncharged.
Q17) Calculate the current through R_1 at the instant the switch S is closed (I_0) and after a very long time has passed (I_∞) following the closing of the switch.

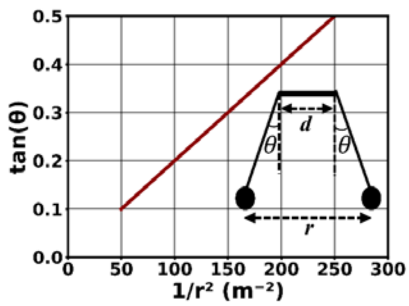


A) $I_0=0,\ I_\infty=0$ B) $I_0=2\ mA,\ I_\infty=0$ C) $I_0=0,\ I_\infty=4\ mA$
D) $I_0=4\ mA,\ I_\infty=0$ E) $I_0=0,\ I_\infty=2\ mA$

Q18) After the switch has remained closed for a long time, it is opened. Given that the capacitor is fully charged at the instant the switch is opened (t = 0), which of the following describes the time dependent function of the charge Q(t) on the capacitor after the switch is opened?

A) $Q(t) = \left(\frac{1000}{9}\,\mu C\right)(1 - e^{-20t})$ B) $Q(t) = \left(\frac{1000}{9}\,\mu C\right)e^{-20t}$ C) $Q(t) = \left(\frac{500}{9}\,\mu C\right)e^{-36t}$
D) $Q(t) = \left(\frac{500}{9}\,\mu C\right)(1 - e^{-36t})$ E) $Q(t) = (40\,\mu C)e^{-20t}$

Q19) Exp. Question: Two identical spheres, each of mass 5 g and charge +100 nC, are suspended by insulating strings. The distance d between the points of suspension is adjusted to different values. In each case, the angle θ made by the spheres with the vertical and the distance r between the centers of the spheres are measured, and the graph tan(θ) = f(1/r²) is obtained. Based on this graph, what value was found for the Coulomb constant in N·m²/C²? (g=10 m/s²)



A) 9×10^9 B) 1×10^{10} C) 8×10^9 D) 8×10^{10} E) 7×10^9

Q20) Exp. Question: For two unknown resistors, the slope of the $I = f(V)$ graph obtained when the resistors are connected in series is calculated as 0.01 A/V. When the same resistors are connected in parallel, it is observed that, for the same voltage values, the current in the circuit is 4 times the current in the series-connected case $\left(\frac{I_p}{I_s} = 4\right)$. Which of the following is the pair of resistors used in the experiment?

A) 25 Ω – 75 Ω B) 40 Ω – 60 Ω C) 50 Ω – 50 Ω D) 20 Ω – 80 Ω E) 100 Ω – 100 Ω