Name, Surname: «First_Name» «Last_Name»	**Student ID Number: «ID»**
Exam Room: «Exam_Room»	**Signature:**

KOÇ UNIVERSITY

College of Sciences

PHYS 102 General Physics 2

Spring Semester 2022

Midterm 2 Exam

April 26, 2022 Tuesday, 20:40-22:10

Please read.

- Please turn off mobile phones and stow away your belongings. Have your student ID ready for attendance check. Only exam booklet, pencil and eraser are allowed throughout the exam.
- Check that there are 4 question sheets in this question booklet.
- Use only black pencil for writing.
- Write your **name, number, on front page, and student ID on each page.**.
- Write neatly and clearly; unreadable answers will not be given any credit.
- **Final answers must be written into the respective answer box. It may not get credit otherwise.**
- A final answer that is not based on a reasonable, consistent solution attempt on the exam paper may not get credit even if it coincides with the correct answer.
- Use the back pages in case you need more blank space. Label the continuing solution clearly.

IMPORTANT: Do not continue the solution of a question on a different question sheet!

- Mathematical expressions in the result must be simplified as possible. Mathematical and physical constants may be left in symbolic form, unless their numerical value for a calculation is explicitly requested in the problem.
- If applicable, make sure to include units in your final answer.
- In graphing questions, use proper scaling, label the axes and indicate units.
- Using calculators is not allowed.
- Students must respect the time restrictions on leaving/entering the exam room as stated by the exam proctors.

Integrals:

$$\int x^n dx = \frac{x^{n+1}}{n+1} \quad (n \neq -1) \qquad \int \frac{dx}{x} = \ln x \qquad \int e^{ax} dx = \frac{1}{a} e^{ax}$$

$$\int \sin ax\, dx = -\frac{1}{a}\cos ax \qquad \int \cos ax\, dx = \frac{1}{a}\sin ax \qquad \int \frac{dx}{\sqrt{a^2 - x^2}} = \arcsin\frac{x}{a}$$

$$\int \frac{dx}{\sqrt{x^2 + a^2}} = \ln\left(x + \sqrt{x^2 + a^2}\right) \qquad \int \frac{dx}{x^2 + a^2} = \frac{1}{a}\arctan\frac{x}{a} \qquad \int \frac{dx}{(x^2 + a^2)^{3/2}} = \frac{1}{a^2}\frac{x}{\sqrt{x^2 + a^2}}$$

$$\int \frac{x\, dx}{(x^2 + a^2)^{3/2}} = -\frac{1}{\sqrt{x^2 + a^2}}$$

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1	2	3	4	Total

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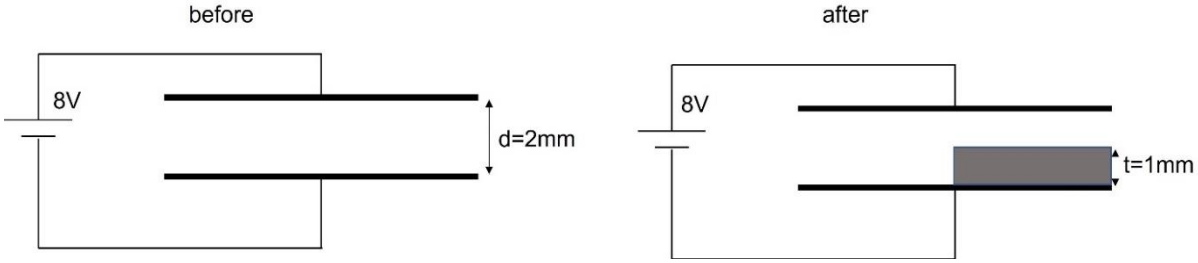
Q1-(25 pts) A $\mathbf{2}\ \boldsymbol{mm}$ air-gap parallel plate capacitor with capacitance $\boldsymbol{C_0 = 6\ mF}$ is connected to an ideal battery of $\mathbf{8\ V}$. Then, a dielectric slab of thickness $\boldsymbol{1mm}$ with dielectric constant $\boldsymbol{K = 2}$ is inserted to completely occupy the lower right quarter of the space between the plates of the capacitor, as shown.



a) Calculate the capacitance of the capacitor with the dielectric slab in place.

C=

b) Calculate the total charge stored in the capacitor with the dielectric slab.

Q=

c) Calculate the amount of work required to remove the dielectric slab from the capacitor.

W=

Solution continues on the back side of the page **Yes** □ **No** □

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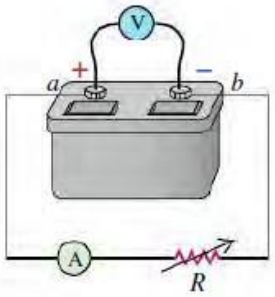
Q2-(25 pts) A *variable* resistor, R, whose value ranges from 0 to ∞ is connected between the terminals of a battery that has an emf $\varepsilon = 18.0\,V$, and an internal resistance of $4.00\,\Omega$. The ammeter and voltmeter are idealized meters.



a) (8 pts.) As R varies over its full range of values, what will be the largest and smallest readings of the voltmeter and ammeter? Justify each answer with statement and/or direct calculation below.

$V_{min} =$
$V_{max} =$
$I_{min} =$
$I_{max} =$

b) (8 pts.) The power dissipated at the variable resistor is 18.0 W. What can be the maximum reading on the voltmeter in this case?

$V_{18W} =$

c) (9 pts.) Suppose we replace the variable resistor with a cylindrical wire of length 8.0 cm and cross section diameter 0.5 cm. The voltmeter reads 15.0V. Calculate resistivity of the cylindrical wire, the magnitudes of the current density and the electric field through the wire.

$J =$
$E =$
$\rho =$

Solution continues on the back side of the page **Yes** □ **No** □

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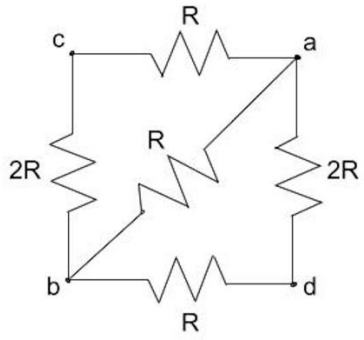
Q3-(25 pts) Consider the resistive circuit in the figure for the questions below. Make sure that your answers are justified by accompanying calculations or arguments.



a) (8 pts.) Calculate the resistance R_{bc} that an ohmmeter would measure between the points b and c.

$R_{bc} =$

b) (12 pts.) A battery with an emf value of V is attached between the points c and d. Find the magnitude of the currents on the edges ab, ac, ad and determine which one dissipates the most power.

$I_{ab} =$
$I_{ac} =$
$I_{ad} =$
Max power on ….

c) (5 pts.) Calculate the resistance R_{cd} that an ohmmeter would measure between the points c and d.

$R_{cd} =$

Solution continues on the back side of the page **Yes** □ **No** □

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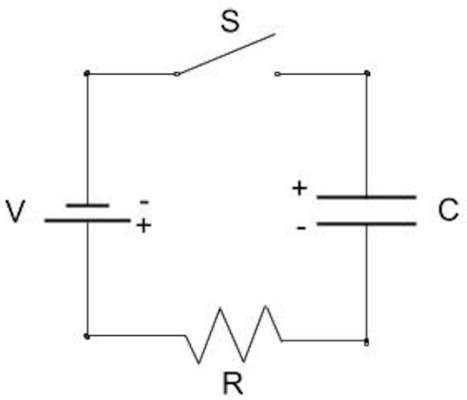
Q4-(25 pts) A capacitor with a capacitance C is fully charged by a battery with an emf value of V. Then, the polarity of the battery is reversed to reach the configuration shown in the figure, and the switch S is closed at time $t = 0$. Express your answers to the questions below in terms of the variables V, C, R, t.



a) (4 pts.) What are the initial and final charges on the capacitor's upper plate?

$Q_i =$

$Q_f =$

b) (10 pts.) Kirchhoff's loop law can be expressed as a differential equation for the charge $q(t)$ on the upper plate as: $\frac{dq}{dt} + Aq + B = 0$. Find A and B. (No partial grade for answers with the wrong sign.)

$A =$

$B =$

c) (11 pts.) Find an expression for $q(t)$.

$q(t) =$

Solution continues on the back side of the page **Yes** □ **No** □