23S-PHYSICS-1B-LEC-3 Midterm4_typeB

SANJIT SARDA

TOTAL POINTS

38 / 40

QUESTION 1

1 Integrity Statement signature (required **0 / 0**

✓ **- 0 pts** *not an imposter*

- 0 pts imposter?

QUESTION 2

Multiple choice 10 pts

2.1 MC #1 **2 / 2**

✓ **- 0 pts** *Correct*

- 2 pts Incorrect

2.2 MC #2 **2 / 2**

✓ **- 0 pts** *Correct*

- 2 pts Incorrect

2.3 MC #3 **2 / 2**

✓ **- 0 pts** *Correct*

- 2 pts Incorrect

2.4 MC #4 **2 / 2**

✓ **- 0 pts** *Correct*

- 2 pts Incorrect

2.5 MC #5 **2 / 2**

✓ **- 0 pts** *Correct*

- 2 pts Incorrect

QUESTION 3

Workout II.1 Charges in a square 10 pts

3.1 Potential V at center **2 / 2**

✓ **+ 2 pts** *Correct*

+ 1.5 pts Correct V for each individual charge

3.2 Potential halfway between bottom charges **4 / 4**

✓ **+ 4 pts** *Correct*

+ 2 pts Correct V for +q

+ 2 pts Correct V for -q

+ 0 pts Blank

3.3 Kinetic energy of charge **4 / 4**

+ 4 pts Correct

+ 0 pts Blank

+ 4 *Point adjustment*

Error carried forward

QUESTION 4

Workout II.2 Infinite charged cylinder 10 pts

4.1 Diagram of E and equipotentials **5 / 5**

✓ **- 0 pts** *Absolute Baller*

- 1 pts Drew field lines inside cylinder (there

should not be electric field in the cylinder!)

- 1 pts Reversed the direction of the electric field (It should be outwards, not inwards!

- 1 pts Missing or incorrect potential lines

- 1 pts Electric field is not radial

- 1 pts no field lines outside

- 0.5 pts Incorrect diagram, did not draw a cross section

- 0.5 pts incorrect additional arrows/other small errors

4.2 Delta V from the center **3 / 5**

+ 5 pts What a legend

✓ **+ 0.5 pts** *Universal Basic Income*

✓ **+ 1 pts** *Gauss' law approach for electric field or decent attempt to solve for electric field*

+ 0.5 pts $$1/r$$ form for electric field

+ 0.5 pts correct result for electric field

✓ **+ 1.5 pts** *integral of $$-Edr$$ to find voltage*

+ 0.5 pts $$ln[r]$$ form for voltage by **correct** integration of $$1/r$$ form for *electric field specifically*

+ 0.5 pts correct result for voltage, error carried forward, or general partial credit

+ 1.5 pts [**Partial**] attempt to solve the question by integration or usage of $$kdq/r$$ (this is not the right approach!!)

Awarded in place of all other credit

+ 1 pts [**Partial**] pity points :(

Awarded in place of all other credit

+ 0 pts contact me for a rescan request!! very blurry/cut off

QUESTION 5

Workout II.3 Thundercloud 10 pts

5.1 Capacitance between cloud and Earth **4 / 4**

✓ **+ 4 pts** *Used the Capacitance formula (C=ϵA/d). Got the right units. Obtained the final numeric value C = 6.25x10^-8 F*

+ 3 pts Used the Capacitance formula (C=ϵA/d). Got the right units. Made a calculation error.

+ 2 pts Left the answer in formula form did not proceed to evaluate.

+ 1 pts Inconsiderable attempt used the wrong formula to begin with.

5.2 Potential Delta V between cloud and Earth **3 / 3**

✓ **+ 3 pts** *Used the right formula to calculate voltage V=Ed. Managed to calculate E. Got the final answer to be V = 1.60x10^8 V*

+ 2 pts Used the right formula to calculate voltage V=Ed. Managed to calculate E. Made a calculation error in the final answer.

+ 1 pts Inconsiderable attempt used the wrong formula to begin with.

5.3 Electrical energy stored (boom!) **3 / 3**

✓ **+ 3 pts** *Used the right formula to calculate the amount of potential energy U= 1/2 CV^2. Obtained the final answer to be 8x10^8 J*

+ 2.5 pts Used the right formula to calculate the amount of potential energy U= 1/2 CV^2. Made a calculation error in the final answer.

+ 1 pts Inconsiderable attempt used the wrong

formula to begin with.

Name: Sanjit Sarda

Student ID #: 805964031

Signature: Sanjit Sarda

May 30, 2023

Physics 1B Midterm Exam #4, version B

- You have 50 minutes to complete this exam. You MUST close the exam and hand it in at the front when time is up. Show your student ID when handing in your exam. If we have to come collect your exam from your row, your exam will be marked so that 25% will be immediately deducted.
- Numerical values in answers: quote values with 3 significant figures, for example, 0.262 or 3.72×10^3. Express your answers in SI units unless indicated otherwise.

- Exam rules:
  - The last sheet of the exam is an equation sheet that should be torn off. It can be thrown away after the exam. Fit all relevant calculations on the front of the pages.
  - You can use any type of calculator that does not have internet capability. Silence and put away your cell phones and laptops.
  - If you have questions during the exam, raise your hand. If you are not seated near the end of a row, you may need to come to the aisle or down to the front of the room to ask them.
  - You MUST sign and date the 2nd page entitled "Academic Integrity – A Bruin's Code of Conduct" in order to receive credit for your work.

- Remember to write down each step of your calculation, and explain your answers fully.

Score :

I.1-5	(Multiple choice)	_____/10 points
II.1		_____/10 points
II.2		_____/10 points
II.3		_____/10 points
	Total score	_____/40 points

Academic Integrity - A Bruin's Code of Conduct:

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If you engage in these types of unacceptable behaviors in our course, then you will receive a zero as your score for that assignment. If you are caught cheating on an exam, then you will receive a score of zero for the entire exam. These allegations will be referred to the Office of the Dean of Students and can lead to formal disciplinary proceedings. Being found responsible for violations of academic integrity can result in disciplinary actions such as the loss of course credit for an entire term, suspension for several terms, or dismissal from the University. Such negative marks on your academic record may become a major obstacle to admission to graduate, medical, or professional school.

We cannot make exceptions to our campus' policy on academic integrity, and as we hopefully have communicated effectively here, penalties for violations of this policy are harsh. Please do not believe it if you hear that "everyone does it". The truth is, you usually don't hear about imposed disciplinary actions because they are kept confidential. So our advice, just don't do it! Let's embrace what it means to be a true Bruin and together be committed to the values of integrity.

By submitting my assignments and exams for grading in this course, I acknowledge the above-mentioned terms of the UCLA Student Code of Conduct, declare that my work will be solely my own, and that I will not communicate with anyone other than the instructor and proctors in any way during the exams.

Sanjit Sarda
Signature

5/30/2023
Date

Sanjit Sarda
Print Name

805964031
UID

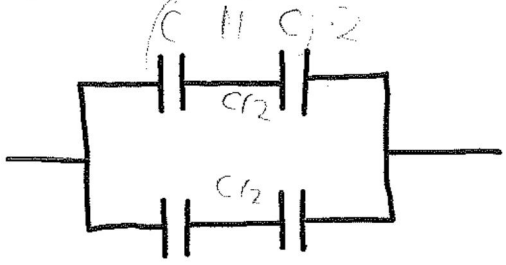
I) Multiple Choice - circle the *one* most correct answer to each question.

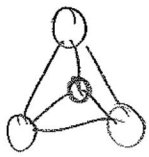
1. Dielectrics in capacitors: C

   a. Increase the possibility of sparking or breakdown.
   b. Reduce the capacitance by reducing the electric field strength.
   c. They keep the conducting plates from coming into physical contact.
   d. All of the above.
   e. None of the above.

2. Capacitors, each having capacitance C, are connected by wires as shown below. The equivalent capacitance of the combination is: C

   a. $C/4$
   b. $2C/5$
   c. C
   d. $2C$
   e. $5C/2$





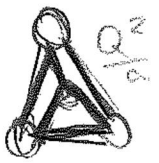
3. Which statement about electrical potential is correct: E

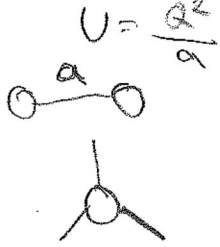
   a. Electric potential is always zero at infinity.
   b. In general, an electrical potential difference ΔV_{ab} depends on the path taken between a and b.
   c. Electric potential increases along a path taken parallel to the electric field.
   d. The electric potential of a point charge varies with distance r from the charge like $1/r^2$.
   e. Lines of equal potential are perpendicular to electric fields.

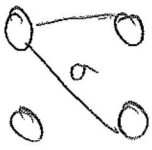
4. Suppose it takes a certain amount of energy U to bring two protons together at a distance a. How much energy does it take to bring four protons together in a tetrahedron where the distance between each pair of protons is a? D

   a. U
   b. $3U$
   c. $4U$
   d. $6U$
   e. $9U$

3+2+1

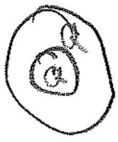






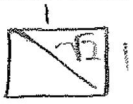
5. A point charge $+Q$ sits at the center of a spherical shell made of conducting material. The shell has inner radius R_1 and outer radius R_2. The spherical shell has no net charge. What is the magnitude of the difference in electrical potential between the inner and outer radii (R_1 and R_2) of the shell? D

   a. kQ/R_2
   b. $kQ/(R_2 - R_1)$
   c. $kQ[1/R_1 - 1/R_2]$
   d. 0
   e. $kQ[1/R_1^2 - 1/R_2^2]$

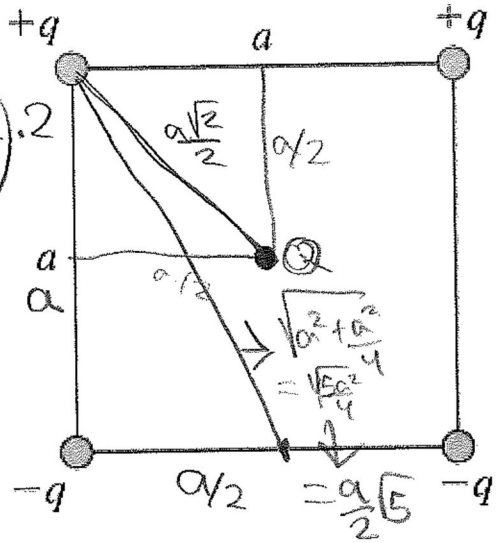


II) Work-out problems

II.1 (10 points) Point charges are placed at each corner of a square with side length a. The charges all have the same magnitude q. Two of the charges are positive and two are negative, as shown in the following figure. Assume electrical potential is zero at infinity.



a) (2 pts) What is the electrical potential at the center of the square?
b) (4 pts) What is the electrical potential halfway along the line *between the two negative charges*?
c) (4 pts) What would be the kinetic energy of a charge Q, that was initially placed at rest at the center of the square, at the time it got to the position in part b)? Work out the numerical answer for the specific case that $a = 1.00 \cdot 10^{-3}\ m$, the magnitude of all of the corner charges are $|\pm q| = 2.00 \cdot 10^{-9}\ C$, and $Q = 5.00 \cdot 10^{-9}\ C$. Assume the positions of the four corner charges $\pm q$ are fixed.



(a) $V = \sum k \frac{q_i}{r_i} = (9E9)\cdot\frac{+q}{\frac{a\sqrt{2}}{2}}\cdot 2 + (9E9)\cdot\frac{-q}{\frac{a\sqrt{2}}{2}}\cdot 2$

$= \frac{(3.6E10)}{\sqrt{2}}\cdot\frac{q}{a} - \frac{(3.6E10)}{\sqrt{2}}\frac{q}{a}$

$= 0$

(b) $V = \sum k \frac{q_i}{r_i} = (9E9)\frac{2q}{a\sqrt{5}}\cdot 2 + \left(9E9\frac{(-2q)}{a}\right)\cdot 2$

$= \frac{(3.6E10)}{\sqrt{5}}\cdot\frac{q}{a} - (1.8E10)\cdot\frac{q}{a}$

$= -(1.9E9)\cdot\frac{q}{a}$

(c) $\Delta K = -\Delta U = -qV$

$\therefore \Delta K = (1.9E9)\left(\frac{q}{a}\right)\cdot a$

$= \frac{mv_f^2}{2} + \frac{mv_i^2}{2} = (1.9E9)\left(\frac{q}{a}\right)\cdot Q$

$\therefore mv_f^2 = (3.8E9)\cdot\frac{q}{a}\cdot Q$

$\therefore v_f = \sqrt{\frac{(3.8E9)}{m}\cdot\frac{q}{a}\cdot Q} = \sqrt{\frac{(3.8E9)}{9.11E-31}\cdot\frac{2E-9}{1E-3}\cdot 5E-9}$

$= 6.46E12\ ms^{-1}$

$= 6.4585E12$

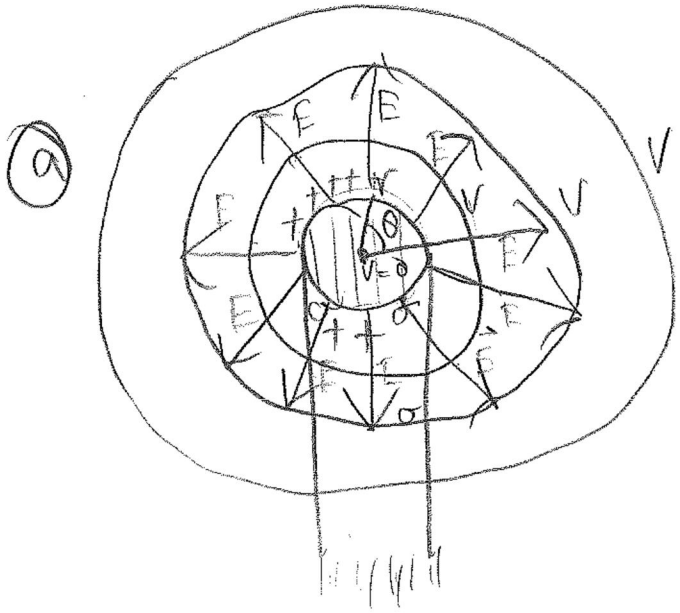
$= 6.4585E12\ ms^{-1}$

(blank extra page if needed for problem II.1)

II.2 (10 points): An infinitely long cylinder of radius R has constant positive surface charge density σ. The thickness of the cylinder is negligibly small. There is no charge inside of the cylinder.

a) (5 pts) Make a diagram that shows the cylinder in cross-section (in other words, the r and θ view, with z along the cylinder not shown), at least 8 electric field lines, and at least 3 equipotential lines. Take $V = 0$ at the center of the cylinder at $r = 0$.

b) (5 pts) Find the electric potential difference ΔV between the center of the cylinder at $r = 0$ and position a outside the cylinder at radius $r_a > R$.



(b) $\Delta V = -\int_a^b \vec{E}\cdot d\vec{l} = -\int_r^{r_a} \frac{\sigma}{\epsilon_0} dl$

$= -\frac{\sigma l}{\epsilon_0}\Big|_r^{r_a}$

$= -\frac{\sigma}{\epsilon_0}(r_a - r)$

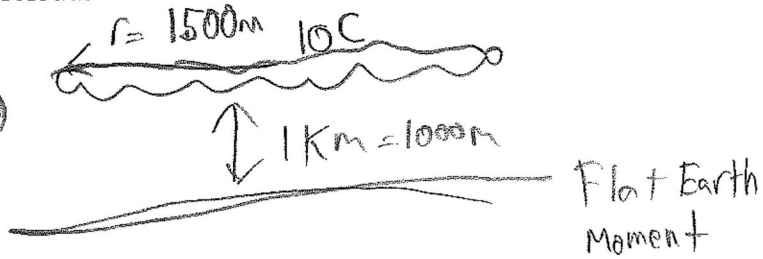
$\therefore \Delta V = -\frac{\sigma}{\epsilon_0}(r_a - r)$

(blank extra page if needed for problem II.2)

II.3 (10 points) A thundercloud, drifting 1.0 km above the earth's surface, contains 10 Coulombs of negative charge. Assume the thundercloud is a circular disk of radius 1.5 km parallel to the Earth's surface. Modeling the cloud and the earth's surface as plates of a parallel-plate capacitor, calculate the following quantities:

a) (4 pts) The capacitance between the thundercloud and the earth.
b) (3 pts) The magnitude of the potential difference between the thundercloud and earth.
c) (3 pts) The electrical energy stored in the system.

Note: treat this as an infinite-plane parallel-plate capacitor, ignoring edge effects due to the finite radius of the thundercloud.



(a) $C = \epsilon_0 \frac{A}{d} = (8.85E-12) \cdot \frac{\pi(1500^2)}{1000} = 6.255E-8\,F$

$= 6.26E-8\,F$

(b) $Q = CV \therefore 10 = (6.255E-8) \cdot V$

$\therefore V = \frac{10}{6.255E-8} = 1.5985E8\,V$

$= 1.60E8\,V$

(c) $U = \frac{1}{2}CV^2 = \frac{1}{2} \cdot (6.255E-8) \cdot (1.5985E8)^2$

$= 7.9927E8\,J$

$= 7.99E8\,J$

(blank extra page if needed for problem II.3)