23S-PHYSICS-1B-LEC-3 Midterm3_typeA

SANJIT SARDA

TOTAL POINTS

38.5 / 40

QUESTION 1

Integrity statement (required) 0 pts

1.1 Signature and name **0 / 0**

✓ **- 0 pts** *IMPOSTER ALERT OUT THE AIRLOCK WITH YOU*

1.2 Up to +2 points for grade curve adjustment **2 / 0**

+ 0 pts Correct

+ 2 *Point adjustment*

QUESTION 2

2 Multiple choice #1 **2 / 2**

✓ **+ 2 pts** *Correct*

+ 0 pts wrong

QUESTION 3

3 Multiple choice #2 **2 / 2**

✓ **+ 2 pts** *Correct-b*

+ 0 pts wrong

QUESTION 4

4 Multiple choice #3 **2 / 2**

✓ **+ 2 pts** *D Correct*

+ 0 pts wrong

QUESTION 5

5 Multiple choice #4 **0 / 2**

+ 2 pts C Correct

✓ **+ 0 pts** *wrong*

QUESTION 6

6 Multiple choice #5 **2 / 2**

✓ **+ 2 pts** *A Correct*

+ 0 pts Wrong

QUESTION 7

II.1 Charges in a square 10 pts

7.1 Direction of net electric field **2 / 2**

✓ **+ 2 pts** *Wrote down the right direction with appropriate explanation.*

+ 1 pts Wrote down the right direction but was not able to explain why the electric field resulted in downward direction.

+ 0 pts Wrong direction. Inconsiderable attempt.

7.2 E magnitude at center **5 / 5**

✓ **+ 5 pts** *Calculated r = a/√2*

*Utilized the formula Ey = - (1/√2)*Ei*

Finally multiplied by 4 to consider all the charges present which resulted in the equation Ey = - (4√2)(kq/a^2)*

+ 4 pts Left r as r throughout the equation and

did not change it to a/$\sqrt{2}$. Any other minor mistake.

+ 3 pts Did not take into consideration the presence of 4 charges by not multiplying 4 into the final equation.

+ 2 pts wrote down all the formulae and did not evaluate further to reach the final form or concluded that E is 0.

+ 0 pts inconsiderable attempt

7.3 Force on a charge at the center **2 / 3**

+ 3 pts Used the formula F=Q.E and obtained the right answer, Also described the direction of the force to be downward (same as direction of electric field)

✓ **+ 2 pts** *Made a calculation mistake in the electric field calculation or did not represent the right direction of the force.*

+ 1 pts Left it in the formula form but identified the right formula to be used to determine the answer.

+ 0 pts inconsiderable attempt.

If the answer is on the back contact professor and find the physical copy.

QUESTION 8

II.2 E from a ring of charge 10 pts

8.1 Q of ring **2 / 2**

✓ **- 0 pts** *Correct*

- 1 pts Incorrect formula for circumference of the ring

- 1.5 pts Incorrect use of line charge density

- 2 pts Incorrect

8.2 Why Ex=Ez=0 **2 / 2**

✓ **- 0 pts** *Correct*

- 1 pts Insufficient

8.3 Calculate dEx **3 / 3**

✓ **+ 3 pts** *Correct*

+ 1 pts Correct dE

+ 1 pts Correct $$dE_x = dE \cdot cos\alpha$$

+ 0 pts Blank

8.4 Total Ex **2.5 / 3**

+ 3 pts Correct

+ 0 pts Blank

+ 2.5 *Point adjustment*

Minor derivation error

QUESTION 9

Solid ball of uniform charge density

10 pts

9.1 Q from rho and r_b **3 / 3**

✓ **- 0 pts** *YAAAAAASSS*

- 0.5 pts Hmm...

squints

I'll give you some points and pretend you were just careless

- 1.5 pts Used Gauss' Law prematurely...

- 1.5 pts Used $$\rho dV$$ instead of $$\rho V$$, or multiplied by $$4\pi r^2$$ instead of $$[4/3]\pi r_b^3$$

- 2 pts NAAAAUUUURRREE

9.2 Direction of the E field inside the ball

2 / 2

✓ **- 0 pts** *YAAAAASSSSS*

- 1 pts Stated that the direction of the field was inwards

- 1 pts Stated that the field was zero inside the ball

- 2 pts Did not state the direction of the field at all

9.3 Magnitude of E field inside the ball **5 / 5**

✓ **- 0 pts** *Such badassery*

- 0.5 pts Did not substitute in $$\rho=Q/([4/3]\pi r_b^3)$$ (or did so incorrectly)

- 1 pts Mixed up $$r_b$$ and $$r$$

- 1.5 pts Incorrect calculation of $$Q_{enc}$$

- 1 pts Incorrect area of gaussian surface (the correct area is $$4\pi r^2)$$

- 4 pts Did not apply Gauss' law

- 0.5 pts Other small mistake, for example, missing a factor of $$\epsilon_0$$ or an additional factor of 2 or 3, or an algebraic error

- 2.5 pts Tried to use a volume integral method of calculating E but did so incorrectly with major mistakes

Name: Sanjit Sarda

Student ID #: 805964031

Signature: Sanjit Sarda

May 16, 2023

Physics 1B Midterm Exam #3, version A

- 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:

UCLA is a community of scholars committed to the values of integrity. In this community, all members including faculty, staff, and students alike are responsible for maintaining the highest standards of academic honesty and quality of academic work. As a student and member of the UCLA community, you are expected to demonstrate integrity in all of your academic endeavors. When accusations of academic dishonesty occur, the Office of the Dean of Students investigates and adjudicates suspected violations of this student code. Unacceptable behavior include cheating, fabrication or falsification, plagiarism, multiple submissions without instructor permission, using unauthorized study aids, facilitating academic misconduct, coercion regarding grading or evaluation of coursework, or collaboration not authorized by the instructor. Please review our campus' policy on academic integrity in the UCLA Student Conduct Code: https://deanofstudents.ucla.edu/individual-student-code

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

6/16/2023
Date

Sanjit Sarda
Print Name

805 969 031
UID

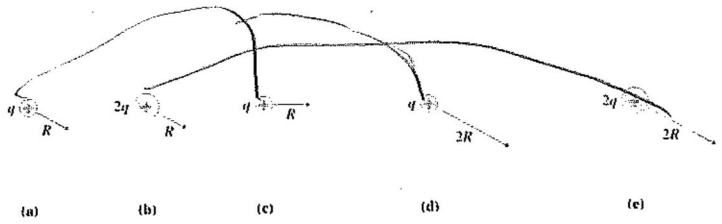
I) Multiple Choice - circle the *one* most correct answer to each question.

1. If an electron is accelerated from rest in a uniform electric field, we can conclude that: B

   a. The electron moves in the direction of the electric field.
   b. The electron moves opposite to the direction of the electric field.
   c. The electron moves perpendicular to the direction of the electric field.
   d. This is a trick question - the electron cannot be accelerated by a uniform electric field.

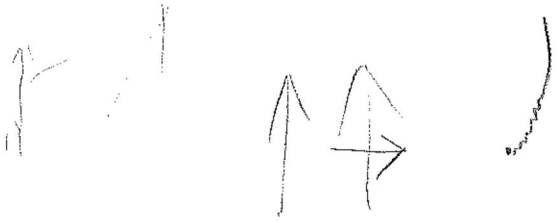
2. In the figure below, two-dimensional cross-sections of spheres and cubes are shown. Rank the order of electric fluxes through surfaces (a) to (e): B

   a. $\Phi_a > \Phi_c > \Phi_b > \Phi_d > \Phi_e$
   b. $\Phi_b = \Phi_e > \Phi_a = \Phi_c = \Phi_d$
   c. $\Phi_e > \Phi_d > \Phi_b > \Phi_c > \Phi_a$
   d. $\Phi_b > \Phi_a > \Phi_c > \Phi_e > \Phi_d$
   e. $\Phi_d = \Phi_e > \Phi_c > \Phi_a = \Phi_b$



3. What is the *most general shape* of the path that a charged particle, which may be moving initially in any direction, will travel in a region of space with the only force coming from a uniform electric field? D

   a. Straight line.
   b. Circle.
   c. Helix.
   d. Parabola.
   e. Hyperbola.

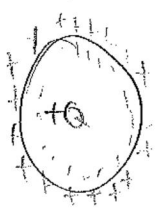


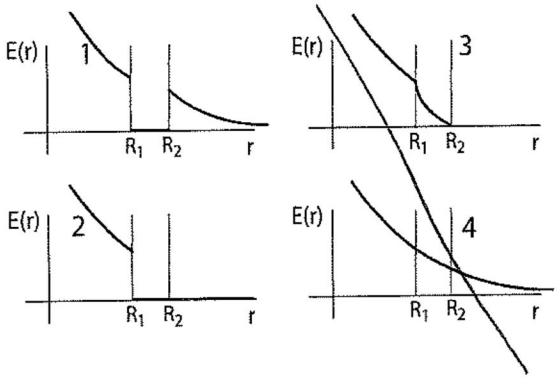
4. The magnitude of the electric field of an electric dipole varies with distance r far away (as compared to the size of the dipole d) as: B

   a. $1/r$.
   b. $1/r^2$.
   c. $1/r^3$.
   d. It does not vary.

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. Which of the following plots best represents the electric field as a function of radius? A

   a. Plot 1.
   b. Plot 2.
   c. Plot 3.
   d. Plot 4.





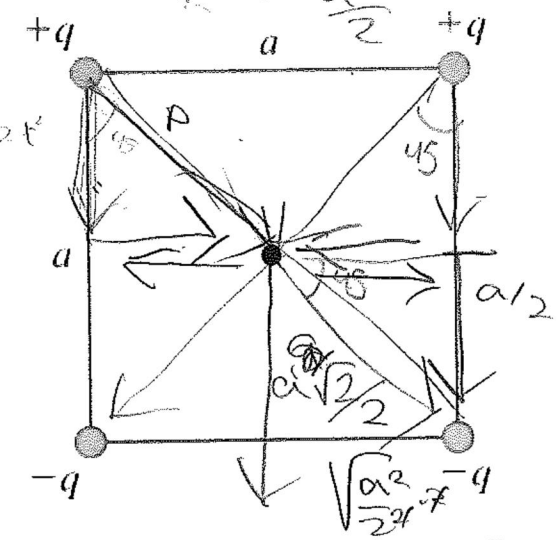
$\frac{2a}{a} = \frac{a}{2}$

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.

a. (2 pts) What is the direction of the net electric field at the center of the square? (Explain your answer.)
b. (5 pts) Calculate the magnitude of the net electric field at the center of the square.
c. (3 pts) If $a = 1.00 \cdot 10^{-3}\ m$ and the magnitude of all of the charges are $|\pm q| = 2.00 \cdot 10^{-9}\ C$, what would be the magnitude and direction of the electrical force on a charge $Q = 5.00 \cdot 10^{-9}\ C$ placed at the center of the square?

(a) To the bottom, because the sideways components cancel out



(b) $F = qE$

~~If an arbitrary charge, q_1, is in the center, $F = q_1 E$ $\therefore E = \frac{F}{q_1}$~~

$\vec{E} = \sum k q_1 \frac{\hat{r}}{r^2} = \sum k q_1 \frac{\vec{r}}{|r|^3}$

$\vec{E} = kq\left(\sum_0^2 \frac{\hat{r}}{r^2}\right) - kq \sum_2^4 \frac{\hat{r}}{r^2}$

We will sum the parts that don't cancel

$= \left(kq \cdot \frac{1}{r^2} \cdot \frac{1}{\sqrt{2}}\right) \cdot 2 - \left(kq \cdot \frac{1}{r^2} \cdot \frac{-1}{\sqrt{2}}\right) \cdot 2 = 4\left(kq \cdot \frac{\sqrt{2}}{a}\right)$

$= \frac{4kq\sqrt{2}}{a}$

(c) $E = \frac{4kq}{a}$ $\therefore E = \frac{4 \cdot (9E9)(2E-9)\sqrt{2}}{1E-3} = 101823 \approx 72000\ \frac{N}{C}$

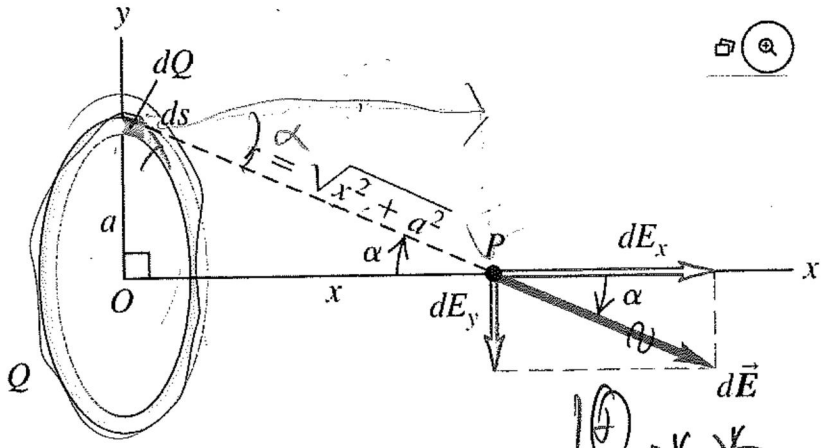
$\therefore \vec{F} = q\vec{E} = 72000 \cdot 5E-9 = 0.000509\ N$ (101823)

0.000509 N Downwards.

0.000509 N

II.2 (10 points) As shown below, charge is uniformly distributed around a ring of radius a placed in the $y-z$ plane with linear charge density λ. We are interested to know the electric field at a point P on the axis perpendicular to the ring at distance x from its center.

a. (2 pts) In terms of the variables already given, what is the charge Q on the ring?
b. (2 pts) Explain in one or two sentences why we know $E_y = 0$ and $E_z = 0$ at point P without calculating them explicitly.
c. (3 pts) Calculate the contribution dE_x from a small segment ds of the ring of charge in terms of ds, k, x, a, and λ.
d. (3 pts) Calculate the total E_x due to the ring of charge in terms of k, x, a, and Q.



(a) $\lambda = \frac{Q}{L} = \frac{Q}{2\pi a} \therefore Q = 2\pi a\lambda$

(b) Because when you integrate/sum over the tiny component vectors around the circle, the ~~direction~~ magnitude along the ~~x~~ y & z are ~~are~~ cancel out.

(c) $dE = k\frac{dQ}{x^2+a^2}\cdot\hat{r}$

$dE_x = k\frac{dQ}{x^2+a^2}\cdot\hat{r} = \frac{k\lambda ds}{x^2+a^2}\cdot\hat{r} = \frac{k\lambda ds}{x^2+a^2}\cdot\cos\alpha = \frac{k\lambda ds}{x^2+a^2}\cdot\frac{x}{\sqrt{x^2+a^2}}$

$Q = \lambda L$

$dQ = \lambda ds$

(d) $\int dE_y = E_x = \int_0^{2\pi a} \frac{k\lambda ds\, x}{(x^2+a^2)^{3/2}} = \frac{k\lambda 2\pi a\, x}{(x^2+a^2)^{3/2}}$ since cancel out

$E_y = \frac{kQx}{(x^2+a^2)^{3/2}}$

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

II.3 (10 points) A solid insulating ball of radius r_b has a uniform positive charge density ρ.

a) (3 pts) In terms of ρ and r_b, how much charge Q does the ball contain?
b) (2 pts) Describe in one sentence the direction of the electric field inside the ball, i.e. with $r < r_b$ from the center of the ball.
c) (5 pts) Calculate the magnitude of the electric field at a distance $r < r_b$ inside the ball in terms of Q, r, r_b, and ϵ_0.

Note: The area of a spherical shell of radius r is $4\pi r^2$, and the volume of a sphere of radius r is $\frac{4}{3}\pi r^3$.

(a) $\rho = \frac{Q}{V} = \frac{Q}{\frac{4}{3}\pi r_b^3} \therefore Q = \boxed{\frac{4\rho\pi r_b^3}{3}}$

(b) The direction of the E field is to the outside of the ball.

(c) ~~$E(r) = \rho$~~

$E \cdot A = \Phi = \frac{Q_r}{\epsilon_0}$

$\therefore E = \frac{Q_r}{A\epsilon_0} = \frac{4\rho\pi r^3}{3 \cdot 4\pi r^2 \cdot \epsilon_0} = \frac{\rho r}{3\epsilon_0}$

$= \frac{3Q}{4\pi r_b^3} \cdot \frac{r}{3\epsilon_0}$

$= \boxed{\frac{Qr}{4\pi\epsilon_0 r_b^3}} = \frac{kQr}{r_b^3}$

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