Physics 1B Quiz 3

NATHAN LIN

TOTAL POINTS

50 / 50

QUESTION 1

1 Honor Pledge 0 / 0

✓ + **0 pts** Correct

QUESTION 2

Problem 1 25 pts

2.1 Part a 10 / 10

✓ + **10 pts** ALL. Note: incorrect steps/answers with no work shown means zero points, e.g. not using Gauss's Law but just guessing.

+ **2 pts** infinite wire: set-up
+ **2 pts** infinite wire: Gauss's Law - NOTE: writing "by Gauss's Law" is not showing work
+ **2 pts** semi-inf wire: set-up
+ **2 pts** semi-inf wire: Coulomb's Law, integration, correct limit, etc.; NOT zero...
+ **2 pts** superpostion; relative signs of fields, etc.
+ **0 pts** N/A or no "work" for either E-field; meaning you can't just start from a given electric field without deriving it yourself

2.2 Part b 5 / 5

✓ + **5 pts** ALL

+ **2 pts** Use E-field of inf wire from part A or show work... If you didn't receive credit for this part then it means you either used the wrong electric field or have no work shown for an incorrect answer.
+ **2 pts** field
+ **1 pts** final
+ **0 pts** N/A

2.3 Part c 10 / 10

✓ + **10 pts** ALL

+ **3 pts** set-up: dF = E*dq (explicit)
+ **4 pts** integration
+ **3 pts** Final
+ **0 pts** N/A

QUESTION 3

Problem 2 25 pts

3.1 Part a 5 / 5

✓ + **5 pts** Correct

+ **0 pts** No credit
+ **3 pts** Incorrect Gaussian surface
+ **2 pts** Partial credit
+ **1 pts** Partial credit
+ **4 pts** Partial credit

3.2 Part b 5 / 5

✓ + **5 pts** Correct

+ **4 pts** Minor algebra error
+ **0 pts** No credit
+ **1 pts** Gauss's law
+ **1 pts** Cylinder area
+ **1 pts** Add field from inner portion
+ **2 pts** Enclosed charge
+ **1 pts** Partial credit

3.3 Part c 5 / 5

✓ + **5 pts** Correct

+ **3 pts** Correct except E = 0 in conductor
+ **0 pts** No credit
+ **1 pts** Gauss's law
+ **2 pts** Partial credit

3.4 Part d 5 / 5

✓ + **5 pts** Correct

+ **4 pts** Algebra error
+ **1 pts** Gauss's law
+ **1 pts** Cylinder

+ **3 pts** Total enclosed charge
+ **1 pts** Partial credit
+ **2 pts** Partial credit
+ **0 pts** No credit

3.5 Part e **5 / 5**

✓ + **5 pts** **Correct**
+ **4 pts** Minor algebra error
+ **0 pts** No credit
+ **3 pts** Partial credit
+ **2 pts** Partial credit
+ **1 pts** Partial credit

Quiz 3

Physics 1B, Fall 2020
November 17, 2020
Dr. Alec Vinson

Students are allowed open notes and open book for this quiz. Besides online materials specifically for this course (e.g. postings on CCLE and the eText), all other online resources are considered unauthorized material access for this quiz.

To receive full credit, the student must **show all work**.

Answers may be typed using typesetting software that can utilize mathematical symbols (e.g. LaTeX, or Microsoft Word in conjunction with the use of its "equation" tool, etc.), or may be written with note-taking software (e.g. Microsoft OneNote, etc.) using a stylus + touchscreen, or may be written on physical paper. If writing on physical paper, the student must save their work by taking pictures, preferably converting those pictures to PDF format.

Student are to submit their work on Gradescope to the appropriate assignment labeled "Quiz 3" before the deadline of 2pm PT on November 17, 2020.

Students are provided a 4 hour window to complete the quiz, though it should only take between one and two hours to complete.

Important: Please print your name on the provided line within the statement below, and then sign your name next to the line marked with an '×' below it. You may do this by signing this paper via note-taking or PDF-editing software, or printing the page, signing it physically, and taking a picture. Alternatively, you may write out the statement on your own piece of paper, exactly as written, sign it, and take a picture. The signed pledge should be the first page of your Quiz 1 submission on Gradescope.

I, Nathan Lin, affirm that I will not give or receive any unauthorized help on this quiz, that all work will be my own, and that I will not share or disseminate the quiz or my solutions in any manner, online, physically, or otherwise.

Sign: × [signature]

1 Honor Pledge **0 / 0**

✓ **+ 0 pts** Correct

Nathan Lin

Quiz 3

1. a. $\lambda = \frac{Q}{L}$, $dQ = \lambda dx$

$E_L = \int dE = \int_{\frac{x}{2}}^{\infty} \frac{k\lambda dx}{x^2}$

$= k\lambda \left[-\frac{1}{x} \right|_{\frac{x}{2}}^{\infty}$

$= k\lambda \left[-\frac{1}{\infty} + \frac{2}{x} \right]$

$E_L = \frac{2k\lambda}{x}$ for left wire

$E_R \cdot A = \frac{Q_{enc}}{\varepsilon_0}$

$E_R (2\pi (\frac{x}{2}) L) = \frac{-2\lambda L}{\varepsilon_0}$

$E_R = \frac{-2\lambda}{\pi x \varepsilon_0}$ for right wire

$E_R = \frac{-8k\lambda}{x}$

$E_p = E_R + E_L$ (same direction)

$E_p = \frac{2k\lambda + |-8k\lambda|}{x}$

$\boxed{E_p = \frac{10 k\lambda}{x}}$ N/C

b. $E_{21} A = \frac{Q_{enc}}{\varepsilon_0}$

$E_{21} (2\pi x L) = \frac{-2\lambda L}{\varepsilon_0}$

$\boxed{E_{21} = \frac{-\lambda}{\pi x \varepsilon_0} \hat{x}}$ N/C * leftward is positive

c. $F_{21} = q E_{21}$, $q = \frac{\lambda}{L}$

$F_{21} = \frac{-\lambda^2}{\pi x L \varepsilon_0}$

$F_{21} = \int dF_{21} = \int_x^{x+L} \frac{-\lambda^2}{\pi x L \varepsilon_0} dx$

$= -\frac{\lambda^2}{\pi L \varepsilon_0} \int_x^{x+L} \frac{1}{x} dx$

$= -\frac{\lambda^2}{\pi L \varepsilon_0} \left[\ln x \right|_x^{x+L}$

$= \frac{-\lambda^2}{\pi L \varepsilon_0} \left[\ln(x+L) - \ln(x) \right]$

$\boxed{F_{21} = -\frac{\lambda^2}{\pi L \varepsilon_0} \left(\ln \left(\frac{x+L}{x} \right) \right) \hat{x}}$ * F_{21} is negative since we declared leftward to be positive, but force faces rightward.

N

2.1 Part a **10 / 10**

✓ **+ 10 pts ALL. Note: incorrect steps/answers with no work shown means zero points, e.g. not using Gauss's Law but just guessing.**

+ **2 pts** infinite wire: set-up
+ **2 pts** infinite wire: Gauss's Law - NOTE: writing "by Gauss's Law" is not showing work
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+ **2 pts** semi-inf wire: Coulomb's Law, integration, correct limit, etc.; NOT zero...
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$= -\frac{\lambda^2}{\pi L \varepsilon_0} \left[\ln x \right|_{x}^{x+L}$

$= \frac{-\lambda^2}{\pi L \varepsilon_0} \left[\ln(x+L) - \ln(x) \right]$

$\boxed{F_{21} = -\frac{\lambda^2}{\pi L \varepsilon_0} \left(\ln\left(\frac{x+L}{x} \right) \right) \hat{x}}$ * F_{21} is negative since we declared leftward to be positive, but force faces rightward.

N

2.2 Part b **5 / 5**

✓ **+ 5 pts** **ALL**

+ 2 pts Use E-field of inf wire from part A or show work... If you didn't receive credit for this part then it means you either used the wrong electric field or have no work shown for an incorrect answer.

+ 2 pts field

+ 1 pts final

+ 0 pts N/A

Nathan Lin

Quiz 3

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2.3 Part c 10 / 10

✓ + **10 pts** **ALL**

+ **3 pts** set-up: dF = E*dq (explicit)
+ **4 pts** integration
+ **3 pts** Final
+ **0 pts** N/A

Nathan Lin

2. a. $0 < r < a$:

$EA = \frac{q_{enc}}{\varepsilon_0}$

$E(2\pi r L) = \frac{\lambda L}{\varepsilon_0}$

$\boxed{E = \frac{\lambda}{2\pi\varepsilon_0 r}\ \hat{r}}$ N/C

b. $a < r < b$: $q_{enc} = \rho V + \lambda L$, $V = \pi L(r^2 - a^2)$

$E(2\pi r L) = \frac{\rho V + \lambda L}{\varepsilon_0}$

$E(2\pi r L) = \frac{\rho(\pi L(r^2 - a^2)) + \lambda L}{\varepsilon_0}$

$\boxed{E = \frac{\lambda + \pi\rho(r^2 - a^2)}{2\pi r\varepsilon_0}\ \hat{r}}$ N/C

c. $b < r < c$:

$\boxed{E = 0}$ since the net electric field inside a conductor is zero

d. $r > c$: $q_{enc} = \rho V + \lambda L$, $V = \pi L(b^2 - a^2)$

$E(2\pi r L) = \frac{\rho\pi L(b^2 - a^2) + \lambda L}{\varepsilon_0}$

$\boxed{E = \frac{\lambda + \pi\rho(b^2 - a^2)}{2\pi r\varepsilon_0}\ \hat{r}}$ N/C

e. $\sigma_i = \frac{-Q_{enc}}{A}$

$= \frac{-(\rho V + \lambda L)}{A}$, $A = 2\pi b L$

$= \frac{-(\lambda L + \rho\pi L(b^2 - a^2))}{2\pi b L}$

$\boxed{\sigma_i = \frac{-(\lambda + \rho\pi(b^2 - a^2))}{2\pi b}}$ C/m^2

$\sigma_o = \frac{\lambda L + \rho\pi L(b^2 - a^2)}{2\pi c L} + \sigma$

$\boxed{\sigma_o = \frac{\lambda + \rho\pi(b^2 - a^2)}{2\pi c} + \sigma}$ since σ_o balances inner surface charge density and adds net σ.

3.1 Part a 5 / 5

- ✓ + **5 pts** **Correct**
- + **0 pts** No credit
- + **3 pts** Incorrect Gaussian surface
- + **2 pts** Partial credit
- + **1 pts** Partial credit
- + **4 pts** Partial credit

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2. a. $0 < r < a$:

$EA = \frac{q_{enc}}{\varepsilon_0}$

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$\boxed{E = \frac{\lambda}{2\pi\varepsilon_0 r}\ \hat{r}}$ N/C

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$\boxed{E = \frac{\lambda + \pi\rho(b^2 - a^2)}{2\pi r \varepsilon_0}\ \hat{r}}$ N/C

e. $\sigma_i = \frac{-Q_{enc}}{A}$

$= \frac{-(\rho V + \lambda L)}{A}$, $A = 2\pi b L$

$= \frac{-(\lambda L + \rho\pi L(b^2 - a^2))}{2\pi b L}$

$\boxed{\sigma_i = \frac{-(\lambda + \rho\pi(b^2 - a^2))}{2\pi b}}$ C/m²

$\sigma_o = \frac{\lambda L + \rho\pi L(b^2 - a^2)}{2\pi c L} + \sigma$

$\boxed{\sigma_o = \frac{\lambda + \rho\pi(b^2 - a^2)}{2\pi c} + \sigma}$ since σ_o balances inner surface charge density and adds net σ.

3.2 Part b 5 / 5

- ✓ **+ 5 pts** Correct
- **+ 4 pts** Minor algebra error
- **+ 0 pts** No credit
- **+ 1 pts** Gauss's law
- **+ 1 pts** Cylinder area
- **+ 1 pts** Add field from inner portion
- **+ 2 pts** Enclosed charge
- **+ 1 pts** Partial credit

Nathan Lin

2. a. $0 < r < a$:

$EA = \frac{q_{enc}}{\varepsilon_0}$

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$\boxed{E = \frac{\lambda}{2\pi\varepsilon_0 r}\ \hat{r}}$ N/C

b. $a < r < b$: $q_{enc} = \rho V + \lambda L$, $V = \pi L(r^2 - a^2)$

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$\boxed{E = \frac{\lambda + \pi\rho(r^2 - a^2)}{2\pi r \varepsilon_0}\ \hat{r}}$ N/C

c. $b < r < c$:

$\boxed{E = 0}$ since the net electric field inside a conductor is zero

d. $r > c$: $q_{enc} = \rho V + \lambda L$, $V = \pi L(b^2 - a^2)$

$E(2\pi r L) = \frac{\rho\pi L(b^2 - a^2) + \lambda L}{\varepsilon_0}$

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$\boxed{\sigma_i = \frac{-(\lambda + \rho\pi(b^2 - a^2))}{2\pi b}}$ C/m²

$\sigma_o = \frac{\lambda L + \rho\pi L(b^2 - a^2)}{2\pi c L} + \sigma$

$\boxed{\sigma_o = \frac{\lambda + \rho\pi(b^2 - a^2)}{2\pi c} + \sigma}$ since σ_o balances inner surface charge density and adds net σ.

3.3 Part c 5 / 5

- ✓ + **5 pts** **Correct**
- \+ **3 pts** Correct except E = 0 in conductor
- \+ **0 pts** No credit
- \+ **1 pts** Gauss's law
- \+ **2 pts** Partial credit

Nathan Lin

2. a. $0 < r < a$:

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3.4 Part d 5 / 5

- ✓ + **5 pts** **Correct**
- + **4 pts** Algebra error
- + **1 pts** Gauss's law
- + **1 pts** Cylinder
- + **3 pts** Total enclosed charge
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- ✓ + **5 pts** Correct
- + **4 pts** Minor algebra error
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