



## Center for Academic Resources in Engineering (CARE) Peer Exam Review Session

Phys 212 – University Physics: Electricity and Magnetism

### Midterm 1 Worksheet

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*The problems in this review are designed to help prepare you for your upcoming exam. Questions pertain to material covered in the course and are intended to reflect the topics likely to appear in the exam. Keep in mind that this worksheet was created by CARE tutors, and while it is thorough, it is not comprehensive. In addition to exam review sessions, CARE also hosts regularly scheduled tutoring hours.*

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Tutors are available to answer questions, review problems, and help you feel prepared for your exam during these times:

Session 1: Sept. 25, 5:30-7:30pm Arnav, Jacob, Krish

Session 2: Sept. 26, 5:30-6:30pm Johan, Aaron, Ray

Can't make it to a session? Here's our schedule by course:

<https://care.grainger.illinois.edu/tutoring/schedule-by-subject>

Solutions will be available on our website after the last review session that we host.

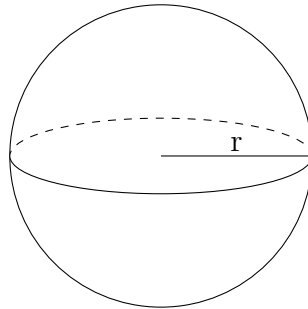
Step-by-step login for exam review session:

1. Log into Queue @ Illinois: <https://queue.illinois.edu/q/queue/848>
2. Click “New Question”
3. Add your NetID and Name
4. Press “Add to Queue”

**Please be sure to follow the above steps to add yourself to the Queue.**

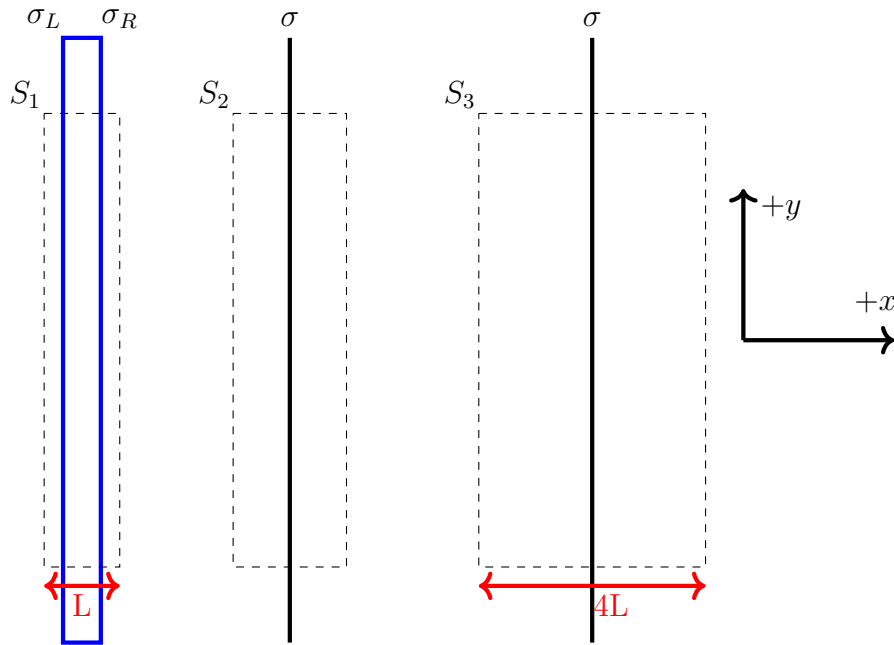
Good luck with your exam!

1. A solid spherical conductor centered at the origin has radius  $r = 90$  cm and carries a total positive charge  $Q = 9 \mu\text{C}$



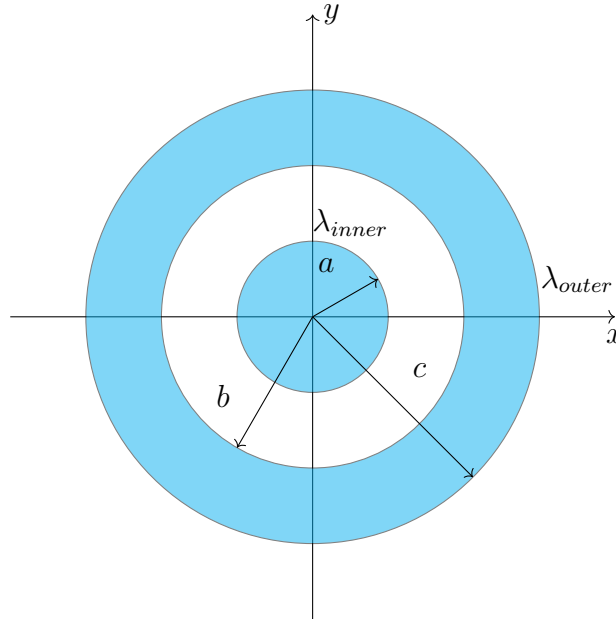
- (i) What is the magnitude of the electric field,  $|E|$ , at a radius of 1.7 m from the origin
- a)  $|E| = 28000$  N/C
  - b)  $|E| = 1.75 \times 10^5$  N/C
  - c)  $|E| = 1 \times 10^5$  N/C
- (ii) If we define the electric potential to be zero at infinity, what is the potential  $V$  at a radius of 1.7 m from the origin? (Note: this is outside of the conducting sphere)
- a)  $V = -47650$  Volts
  - b)  $V = 90000$  Volts
  - c)  $V = 47650$  Volts
  - d)  $V = -90000$  Volts
  - e)  $V = 0$  Volts
- (iii) If we define the electric potential  $V$  to be zero at infinity, what is the potential at a radius of 0.15 m from the origin? (Note: this is inside the conducting sphere)
- a)  $-540000$  Volts
  - b)  $540000$  Volts
  - c)  $-90000$  Volts
  - d)  $90000$  Volts
  - e)  $0$  Volts
- (iv) What would the answer to problem (iii) be if the sphere were an insulator instead of a conductor
- a)  $90000$  Volts
  - b)  $-90000$  Volts
  - c)  $164000$  Volts
  - d)  $-164000$  Volts
  - e)  $134000$  Volts
  - f)  $-134000$  Volts

2. The figure shows three infinite planes. The right two planes are insulating with uniform charge and density  $\sigma = 7 \text{ C/m}^2$ . The left plane is uncharged ( $\sigma_L + \sigma_R = 0$ ) and conducting. Also shown in the figure are three Gaussian surfaces labeled  $S_1$ ,  $S_2$  and  $S_3$ . All three Gaussian surfaces have identical dimensions in the  $yz$  plane, but surface  $S_3$  is 4 times as wide in the  $x$ -direction.



- (i) What is the induced charge on the right side of the conducting slab?
- $\sigma_R = -7 \text{ C/m}^2$
  - $\sigma_R = -14 \text{ C/m}^2$
  - $\sigma_R = -3.5 \text{ C/m}^2$
- (ii) Compare the total flux through Gaussian surface  $S_1$  with the total flux through surface  $S_3$
- $\Phi_1 < \Phi_3$
  - $\Phi_1 = \Phi_3$
  - $\Phi_1 > \Phi_3$
- (iii) Compare the total flux through Gaussian surface  $S_2$  with the total flux through the surface  $S_3$
- $\Phi_2 = \Phi_3$
  - $\Phi_2 < \Phi_3$
  - $\Phi_2 > \Phi_3$

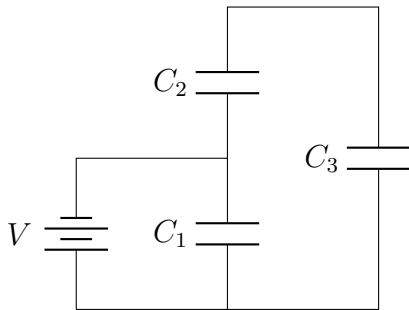
3. A solid, infinite metal cylinder of radius  $a = 2$  cm is centered on the origin, and has charge density  $\lambda_{inner} = -10$  nC/cm. Surrounding this cylinder is a cylindrical metal shell of inner radius  $b = 5$  cm and outer radius  $c = 7.5$  cm. This shell is also centered on the origin, and has total charge density  $\lambda_{shell} = +5$  nC/cm.



- (i) Find the potential difference  $V_a - V_c$  between the surface of metal cylinder ( $r = a$ ) and the outer surface of the metal shell ( $r = c$ ).
- 16.5 kV
  - 8.7 kV
  - 0 kV
  - 8.7 kV
  - 16.5 kV
- (ii) What is the linear charge density,  $\lambda_{shell-outer}$ , on the outer surface of the cylinder shell?
- 5 nC/cm
  - 3 nC/cm
  - 3 nC/cm
  - 0 nC/cm
  - 5 nC/cm
- (iii) If the inner cylinder is connected to ground, the charge density on the inner surface of the outer shell will
- Remain unchanged
  - Decrease in magnitude
  - Increase in magnitude
  - Be zero

- (iv) Assume that the metal cylinder in the center is now switched to an insulating cylinder with the same charge density  $\lambda$  and radius  $a$ . What is its volume charge density,  $\rho$ ?
- 0
  - $-0.80 \text{ nC/cm}^3$
  - $-4.44 \text{ nC/cm}^3$
  - $.80 \text{ nC/cm}^3$
  - $4.44 \text{ nC/cm}^3$

4. The circuit below contains 3 capacitors, all of initial value  $C = 4 \mu\text{F}$ . The voltage source is  $10 \text{ V}$ .



- (i) What is the charge on the capacitor  $C_1$ ?
- $18.3 \mu\text{C}$
  - $21.4 \mu\text{C}$
  - $40.0 \mu\text{C}$
  - $0 \mu\text{C}$
  - $12.0 \mu\text{C}$
- (ii) What is the charge on the capacitor  $C_2$ ?
- $20.0 \mu\text{C}$
  - $19.3 \mu\text{C}$
  - $7.9 \mu\text{C}$
  - $25.6 \mu\text{C}$
  - $25.0 \mu\text{C}$
- (iii) Now suppose  $C_3$  is removed and  $C_2$  is modified by filling it with a dielectric material with constant  $\kappa = 5$ . How does the charge  $Q_2$  change?
- $Q_2$  decreases
  - $Q_2$  stays the same

- c)  $Q_2$  increases
- (iv) Now add  $C_3$  back while the dielectric with constant  $\kappa = 5$  is kept in  $C_2$ . How does the charge  $Q_3$  change from when there was no dielectric?
- a)  $Q_3$  decreases because the capacitance of  $C_3$  decreases relative to that of  $C_2$
  - b)  $Q_3$  stays the same because the charge of capacitors in series is the same
  - c)  $Q_3$  increases because the capacitance of  $C_2$  increases
- (v) How does the charge on  $C_1$  change when  $C_2$  is modified by filling it with a dielectric with constant  $\kappa = 5$ ?
- a)  $Q_1$  decreases because the capacitance of  $C_1$  decreases relative to that of  $C_2$
  - b)  $Q_1$  stays the same because the voltage across  $C_1$  is the same as it was originally
  - c)  $Q_1$  increases because the effective capacitance of  $C_2$  and  $C_3$  part of the circuit increases