Name:_____ Section: _____

Physics 2140

Exam 3

April 9, 2015

- Turn off your cellphone, and put away your headphones (if you have them).
- Do not cheat, and avoid the appearance of impropriety.
- Materials permitted: one sheet of notes and a calculator.
- This test contains 17 questions and 64 points.
- Ask questions when confused! Remain seated and raise your hand.
- Partial credit is available **everywhere.**
- Show your work!
- You are responsible for any corrections or clarifications written on the blackboard.
- Use the blank (_____) for your answer when there is one.
- Circle or box your answer when there isn't a blank.
- Geometric formulae, fundamental constants, and metric prefixes are free for the asking.
- When done, do not stand right outside the door talking about the exam.
- I will post a notice on the website when the grades are available.

$$k = 9 \times 10^9 \,\mathrm{Nm^2/C^2}$$

$$1\,\mu\mathrm{C} = 10^{-6}\,\mathrm{C} \qquad 1\,\mathrm{nC} = 10^{-9}\,\mathrm{C}$$

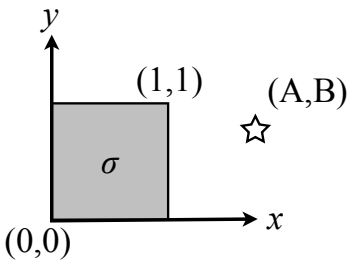
Good luck!

[3] **1.** Suppose I want to find the electric field of a disk (with charge spread across the entire surface), using the integral

$$\vec{E} = k \int \frac{dq}{d^3} \vec{d}$$

_____ Which of the following is dq?
A) $\lambda\, dr$ **B)** $\lambda\, R\, d\theta$ **C)** $\sigma\, dr$ **D)** $\sigma\, r\, dr\, d\theta$ **E)** $\sigma\, R\, dr\, d\theta$

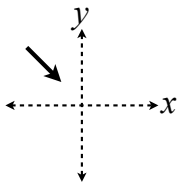
2. Suppose I have a square with surface charge density σ, as shown. I want to find the electric field at coordinates (A, B), using integration.



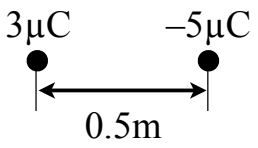
[3] (a) _____ The integration variable(s) is/are...
A) x **B)** y **C)** x and y **D)** z **E)** A and B

[3] (b) _____ What is $\vec{d}$?
A) $A\hat{x} + B\hat{y}$ **B)** $(A-x)\hat{x} + (B-y)\hat{y}$ **C)** $x\hat{x} + y\hat{y}$ **D)** $\hat{x} + \hat{y}$ **E)** $-x\hat{x} + B\hat{y}$

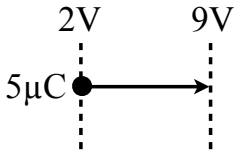
[3] **3.** _____ The vector shown points in which direction?
A) $\hat{r}$ **B)** $-\hat{r}$ **C)** $\hat{\theta}$ **D)** $-\hat{\theta}$



[3] **4.** Consider a 3×10^{-6} C charge and a -5×10^{-6} C charge. When they are far apart, their potential energy is zero. What is their potential energy when they are half a meter apart.



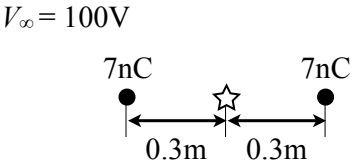
5. I move a 5×10^{-6} C charge from 2 V to 9 V. The charge starts at rest and ends at rest.



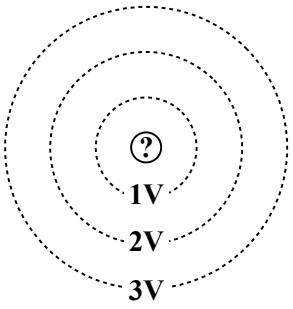
3 (a) _____ What direction does the electric field point in this region?
A) ← **B)** ↑ **C)** → **D)** ↓

3 (b) _____ What work do I do on the charge? (Remember, positive work means I *give* energy to the charge, while negative means I *steal* energy.)
A) -1.4 MJ **B)** $-35\,\mu$J **C)** $-45\,\mu$J
D) $+1.4$ MJ **E)** $+35\,\mu$J **F)** $+45\,\mu$J

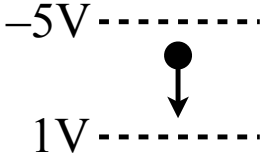
3 **6.** What is the potential halfway between two 7 nC charges that are 0.6 m apart, if the potential at infinity is $V_\infty = 100$ V?



3 **7.** _____ The figure shows three equipotential surfaces created by a sphere in the center. The sphere is
A) positive **B)** neutral **C)** negative



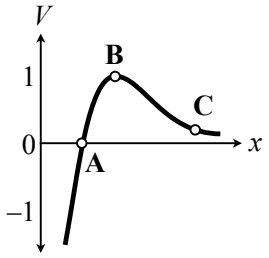
8. A charge is released between two equipotential surfaces (-5 V and 1 V), and spontaneously moves downward.



3 (a) _____ This charge is
A) positive **B)** negative

3 (b) _____ As the charge moves, its potential energy
A) increases **B)** decreases

9. The graph shows the electric potential along a line. Three locations are marked on the graph.

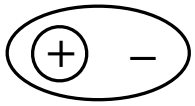


[2] (a) _____ At which point is the electric field zero?

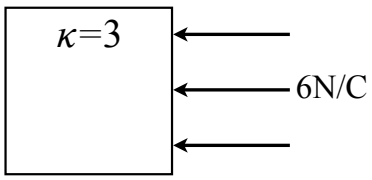
[2] (b) _____ At which point is $\left|\vec{E}\right|$ largest?

[3] **10.** _____ A plasma is a gas where electrons have been stripped from their atoms, and the atoms have positive charge. From this description, we can see that a plasma is
A) a conductor **B)** an insulator

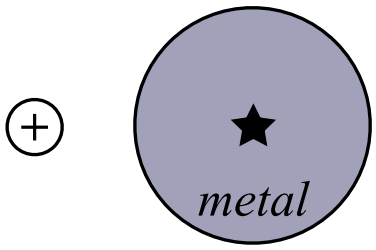
[3] **11.** _____ This atom is polarized by an electric field, which points
A) ← **B)** ↑ **C)** → **D)** ↓



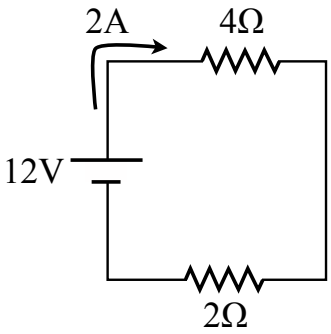
[3] **12.** _____ An insulator with $\kappa = 3$ is placed in an external electric field of 6 N/C which points to the left. What is the *net* electric field inside the insulator?
A) 2 N/C ← **B)** 18 N/C ←
C) 2 N/C → **D)** 18 N/C →



[3] **13.** _____ A positive charge is placed next to a metal sphere. If the sphere is in electrostatic equilibrium, what is the electric field at the center of the sphere (at the star)?
A) ← **B)** 0 **C)** →



14. In this circuit, the current through the 4 Ω resistor is 2 A.

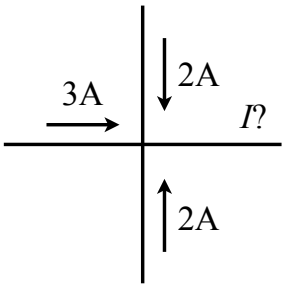


3 (a) _____ What is the potential difference ΔV across the 4 Ω resistor?
A) 0.5 V **B)** 2 V **C)** 4 V **D)** 8 V **E)** 12 V **F)** 16 V

3 (b) _____ What is the power output by the 4 Ω resistor?
A) 0.5 V **B)** 2 V **C)** 4 V **D)** 8 V **E)** 12 V **F)** 16 V

3 (c) _____ What is the current through the 2 Ω resistor?
A) 0.5 A **B)** 1 A **C)** 2 A **D)** 4 A **E)** 8 A

3 **15.** _____ Four wires come together at a junction. What is the current in the rightmost wire?
A) 1 A ← **B)** 1 A → **C)** 3 A ← **D)** 3 A → **E)** 7 A →



3 **16.** A 9 V battery produces 6 W of power. What is the current coming out of it?

+3 **17. Extra Credit:** The electric field in a region has the functional form $\vec{E} = (x+1)\hat{x} + y^2\hat{y}$. Find the potential difference between the two points $(0, 1)$ and $(2, 2)$.