Name: Key

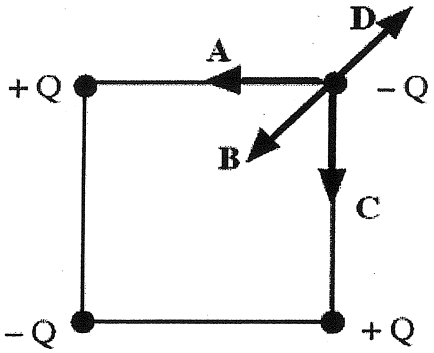
PHY2054.002, Fall 2010
Exam #1

PID:_____

Version A

Part I (60%)

B 1. Four point charges, each of the same magnitude, with varying signs are arranged at the corners of a square as shown. Which of the arrows labeled **A**, **B**, **C**, and **D** gives the correct direction of the net force that acts on the charge at the upper right corner?



A) **A**, B) **B**, C) **C**, D) **D**, E) The net force on that charge is zero.

A 2. Two positive point charges Q and $2Q$ are separated by a distance R. If the charge Q experiences a force of magnitude F when the separation is R, what is the magnitude of the force on the charge $2Q$ when the separation is $2R$?

A) $F/4$, B) $F/2$, C) F, D) $2F$, E) $4F$

C 3. At which point (or points) is the electric field zero N/C for the two point charges shown on the x axis?

A) The electric field is never zero in the vicinity of these charges. B) The electric field is zero somewhere on the x axis to the left of the $+4q$ charge. C) The electric field is zero somewhere on the x axis to the right of the $-2q$ charge. D) The electric field is zero somewhere on the x axis between the two charges, but this point is nearer to the $-2q$ charge. E) The electric field is zero at two points along the x axis; one such point is to the right of the $-2q$ charge and the other is to the left of the $+4q$ charge.

E 4. Which one of the following statements is true concerning the strength of the electric field between two oppositely charged parallel plates?
A) It is zero midway between the plates. B) It is a maximum midway between the plates. C) It is a maximum near the positively charged plate. D) It is a maximum near the negatively charged plate. E) It is constant between the plates except near the edges.

A

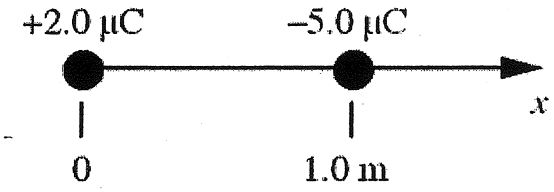
5. What is the electric flux passing through a Gaussian surface that surrounds a +0.075 C point charge?
A) $8.5 \times 10^9 \text{N}\cdot\text{m}^2/\text{C}$, B) $6.8 \times 10^8 \text{N}\cdot\text{m}^2/\text{C}$, C) $1.3 \times 10^7 \text{N}\cdot\text{m}^2/\text{C}$, D) $4.9 \times 10^6 \text{N}\cdot\text{m}^2/\text{C}$
E) $7.2 \times 10^5 \text{N}\cdot\text{m}^2/\text{C}$

D

6. The electric potential at a certain point in space is 12 V. What is the electric potential energy of a –3.0 μC charge placed at that point?
A) +4 μJ, B) –4 μJ, C) +36 μJ, D) –36 μJ, E) zero μJ

B

7. Two point charges are arranged along the *x* axis as shown in the figure. At which of the following values of *x* is the electric potential equal to zero? **Note**: At infinity, the electric potential is zero.



A) +0.05 m, B) +0.29 m, C) +0.40 m, D) +0.54 m, E) +0.71 m

C

8. A parallel plate capacitor with plates of area *A* and plate separation *d* is charged so that the potential difference between its plates is *V*. If the capacitor is then isolated and its plate separation is decreased to *d*/2, what happens to the potential difference between the plates?

A) The final potential difference is 4*V*., B) The final potential difference is 2*V*., C) The final potential difference is 0.5*V*., D) The final potential difference is 0.25*V*., E) The final potential difference is *V*.

D

9. The plates of a parallel plate capacitor each have an area of 0.40 m^2 and are separated by a distance of 0.02 m. They are charged until the potential difference between the plates is 3000 V. The charged capacitor is then isolated. Determine the magnitude of the electric field between the capacitor plates.

A) 60 V/m, B) 120 V/m, C) 1.0×10^5 V/m, D) 1.5×10^5 V/m, E) 3.0×10^5 V/m

E

10. A capacitor has a very large capacitance of 10 F. The capacitor is charged by placing a potential difference of 2 V between its plates. How much energy is stored in the capacitor?

A) 2000 J, B) 500 J, C) 100 J, D) 40 J, E) 20 J

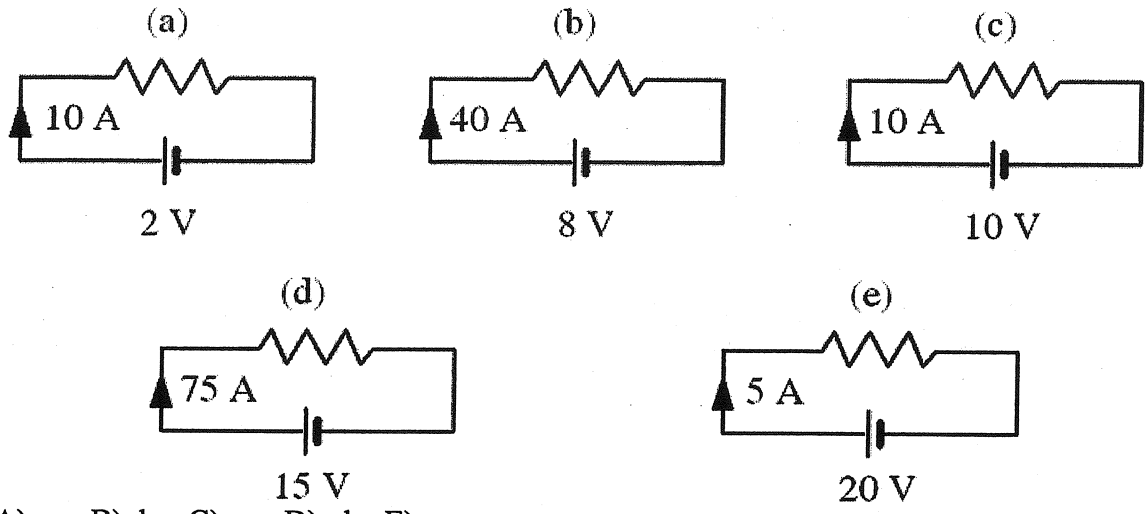
A

11. A 3.5-A current is maintained in a simple circuit with a total resistance of 1500 Ω. What net charge passes through any point in the circuit during a thirty second interval?

A) 100 C, B) 180 C, C) 500 C, D) 600 C, E) 5200 C

E

12. Which one of the following circuits has the largest resistance?

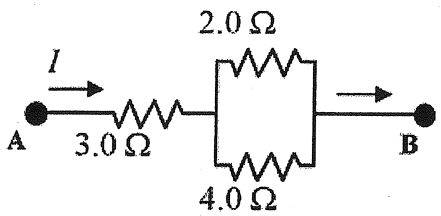


A) a, B) b, C) c, D) d, E) e

D

13. A 4-A current is maintained in a simple circuit with a total resistance of 2 Ω. How much energy is delivered in forty five seconds?

A) 720 J
B) 96 J
C) 360 J
D) 1440 J
E) 240 J



B

14. What is the equivalent resistance between the points **A** and **B** in figure above?

A) 3.8 Ω, B) 4.3 Ω, C) 5.1 Ω, D) 6.8 Ω, E) 9.0 Ω

15. When two capacitors are connected in series, the equivalent capacitance of the combination is 120 μF. When the two are connected in parallel, however, the equivalent capacitance is 480 μF. What are the capacitances of the individual capacitors?

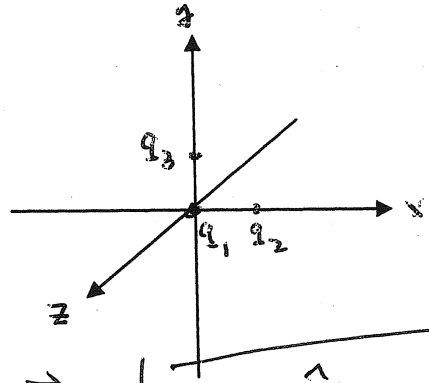
A

A) 240 μF and 240 μF, B) 125 μF and 325 μF, C) 175 μF and 275 μF, D) 150 μF and 300 μF, E) 80 μF and 370 μF

Part II (40%)

$k = 9\times10^9 \frac{Nm^2}{C^2}$

1. A charge $q_1 = -3.0\ \mu C$ is fixed at the origin. There are two more charges, one ($q_2 = -2.0\ \mu C$) is located at x=0.1 m, y=0 and z=0, and the other ($q_3 = +5.0\ \mu C$) at x=0, y=0.1 m, z=0. (a) Find the net electrostatic force acting on the charge at the origin? (10%) (b) Assume a Gaussian sphere with it center located at origin and its radius equals to 0.25m. Find the net electric flux Φ_E through this Gaussian surface. (5%)



(a) $\vec{F}_{12} = -k\frac{(3\times10^{-6})(2\times10^{-6})}{(0.1)^2}\hat{x}$

$= -5.4\,N\,\hat{x}$

$\vec{F}_{13} = +k\frac{(3\times10^{-6})(5\times10^{-6})}{(0.1)^2}\hat{y}$

$= 13.5\,\hat{y}$ $\Rightarrow \vec{F}_{net} = \vec{F}_{12} + \vec{F}_{13} = \boxed{-5.4N\,\hat{x} + 13.5\,\hat{y}}$

(b) $\Phi = \frac{Q_{total}}{\epsilon_0} = \frac{(-3\mu C + -2\mu C + 5\mu C)}{\epsilon_0} = 0$

2. A parallel plate capacitor with a capacitance of 6 μF is charged with a 12 Volts battery until it is fully charged. Once it is fully charged, the battery is disconnected. The distance between the two plates is 1.0 cm. (a) Find the magnitude of the charge on each plate? (5%), (b) What is the electric field in the middle of the capacitor? (5%), (c) If a dielectric with $\kappa = 2.5$ is filled the capacitor, what is the potential difference between the two plates of the capacitor? (5%)

$d = 1.0\,cm \quad C = 6\mu F \quad V = 12\,Volt \quad C = \frac{Q}{V}$

(a) $Q = CV = \boxed{72\mu C}$

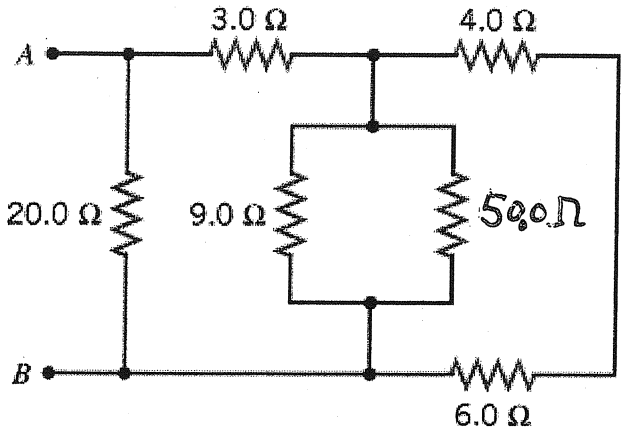
(b) $|E| = \frac{\Delta V}{\Delta s} = \frac{12\,Volt}{0.01\,m} = \boxed{1200\,V/m}$

(c) $C' = KC \quad C' = \frac{q'}{V'}$ since $q' = q$

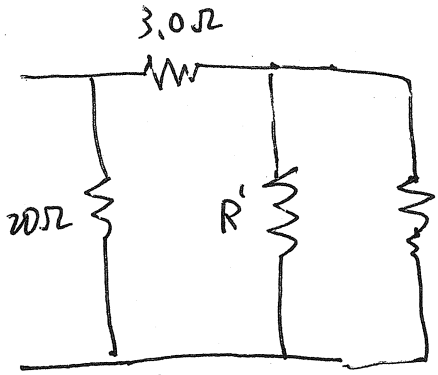
$C' = KC$

$V' = \frac{12}{2.5} = \boxed{4.8\,Volts} \Rightarrow \boxed{V' = \frac{V}{K}}$

3. Determine the equivalent resistance between the points A and B for the group of resistors in the drawing.

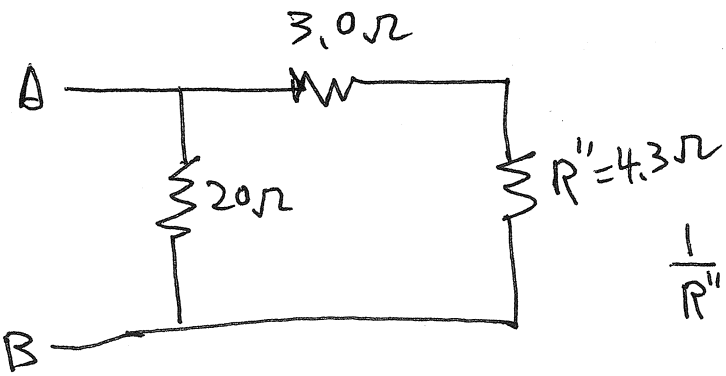


$\Rightarrow$

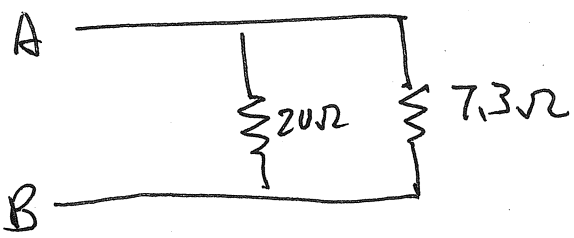


$$\frac{1}{R'} = \frac{1}{9} + \frac{1}{50}$$

$$\boxed{R' = 7{,}6\,\Omega}$$



$$\frac{1}{R''} = \frac{1}{7{,}6} + \frac{1}{10} \Rightarrow R'' = 4{,}3\,\Omega$$



$$\frac{1}{20} + \frac{1}{7{,}3} = \frac{1}{R'''}$$

$$\boxed{R''' = 5{,}35\,\Omega}$$

$\Rightarrow$