PHYS 202 Spring 2019 Test #2 Equations Sheet, You may tear this page. KEY

Heat transfer: $Q = mc\Delta T$ $Q = mL$

Ohm's law: V = IR Electric Power = P = IV Electrical energy =IVt

Resistance in terms of resistivity and dimensions: $R = \rho\frac{L}{A}$

Capacitors: $C = \frac{q}{V}$. $C = \kappa\varepsilon_0\frac{A}{d}$. $Energy = \frac{1}{2}qV = \frac{1}{2}CV^2 = \frac{1}{2}\frac{q^2}{C}$.

Electric potential due to a point charge (q) at a distance r:	Electric potential in terms of EPE and point charge (q):	Electric field due to a point charge (q) at a distance r:	Electric field (E) from potential gradient:
$V = k\frac{q}{r}$	$V = \frac{EPE}{q}$	$E = k\frac{q}{r^2}$	$\vec{E} = -\frac{\Delta V}{\Delta X}$

Combination	Resistors	Capacitors
Series	$R_s = R_1 + R_2 + R_3 + \ldots$	$\frac{1}{C_S} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \ldots.$
Parralel	$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots.$	$C_P = C_1 + C_2 + C_3 + \ldots\ldots$

RC circuits: Time constant = τ = RC, $q = q_0 e^{-\frac{t}{RC}}$ $V = V_0 e^{-\frac{t}{RC}}$

PHYS 202 Spring 2019 Test #2 Name: KEY

I. Select the correct answer for the following multiple choice questions and write your answer in the line next to the question number.

e 1. The *electromotive force* is also known as
a. Force b. Current c. Power d. Energy e. Voltage

e 2. An appliance with a power rating of 600-W is connected to a 120-volt outlet. What is the current through the appliance?
a. 10 A b. 7.2 A c. 0.2 A d. 12 A e. 5 A

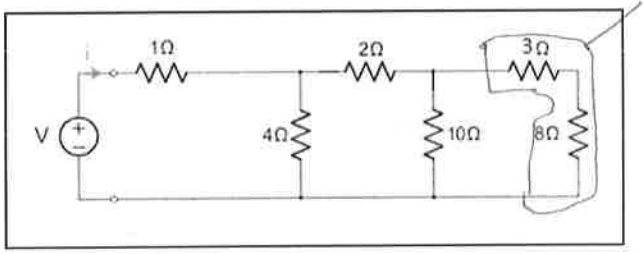
$P = I \cdot V$
$I = P/V = \frac{600}{120} = 5A$

B 3. In a common household circuit, devices are connected in
A. Series B. Parallel

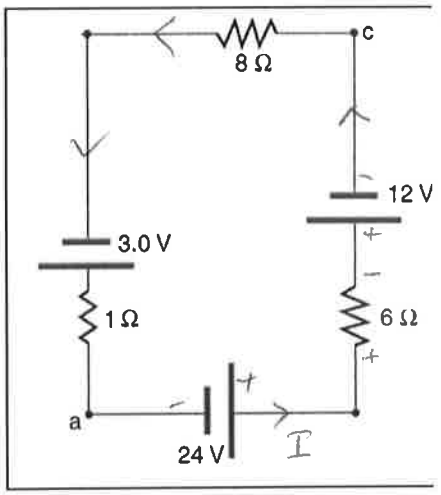
d 4. Which one of the following biomedical application deals with the retina of the eye?
a. EKG b. ECG c. EEG d. ERG e. CEG

d 5. Which one of the following you should do as the first step, to find the equivalent resistance for the network shown below:

Series



a. Combining 4 Ω and 10 Ω in parallel
b. Combining 1 Ω, 2 Ω, and 3 Ω in series
c. Combining 1 Ω, 2 Ω, 3 Ω, and 8 Ω in series
d. Combining 3 Ω and 8 Ω in series
e. Combining 10 Ω and 8 Ω in parallel



b 6. What is the direction of current for the circuit shown?
a. Clockwise b. Counter clockwise

$I = \frac{15}{15} = 1A$

b 7. Determine the magnitude of the current for the circuit shown?
a. 0.6 A b. 1.0 A c. 2.2 A d. 2.60 A e. 15 A

b 8. What is the potential difference, $V_a - V_c$?
a. 2 volt b. 6 volt c. 12 volt d. 18 volt e. 24 volt

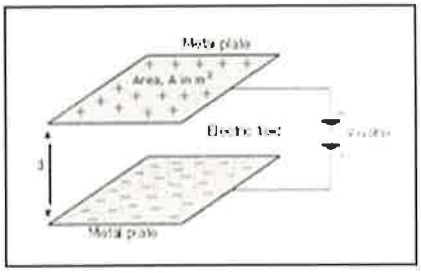
$V_a + 24 - 6 - 12 = V_c$
$V_a - V_c = -6$

e 9. Estimate the yearly cost of electricity for operating a 650-W electric kettle for two times a day for 15 minutes each time, for 20 days a month. Assume a cost of 8 cents per kWh.
a. \$ 0.52 b. \$ 78 c. \$ 1.15 d. \$ 3.12 e. \$ 6.24

$\frac{650}{1000} \times \frac{30}{60} \times 20 \times 12 \times 0.08$

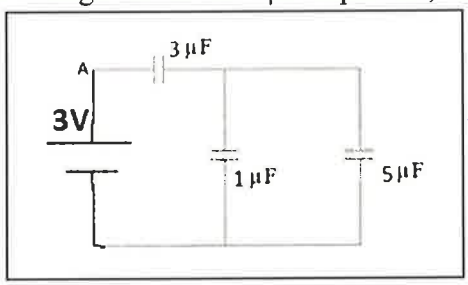
e 10. Two parallel capacitor plates, separated by, d = 1.0 mm, are connected across a 12-V battery. What is the magnitude of the electric field between the plates?

a. 1.2 V/m b. 12 V/m c. 120 V/m
d. 1200 V/m e. 12,000 V/m



C 11. What is the voltage across the 3μF capacitor, below?

a. 1.0 V
b. 1.5 V
c. 2.0 V
d. 2.5 V
e. 3.0 V

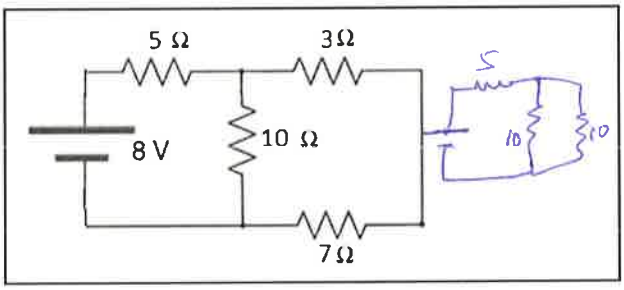


3μF 6μC Series 3V 6μF 3V 2μF 6μC

$V_{3\mu} = \frac{q}{C} = \frac{6}{3} = 2V$

b 12. What is the voltage across the 5 Ω resistor, below?

a. 2 V
b. 4 V
c. 6 V
d. 8 V
e. 0.4 V



$I = \frac{8}{10} = 0.8\ A$

$V_5 = 0.8 \times 5 = 4V$

e 13. A metal wire of length L and cross sectional area A, has a resistance R. This wire is folded into half and both folds are used as the new wire. What is the resistance of the folded, new wire?

a. 4R b. 2R c. R d. ½ R e. ¼ R

end of MC questions

II. A lightning bolt strikes a tree, moving 21.5 C of charge through a potential difference of 92.9 MV. What mass of water could be raised from 17.8°C to the boiling point and then boiled by this energy? Express your answer in SI units with 3 or more significant figures. Specific heat of water = 4186 J/(kg.C°) Latent heat of vaporization of water = 2.256 x 10^6 J/kg.

$V = \frac{EPE}{q} \rightarrow EPE = q \cdot V = 21.5 \times 92.9 \times 10^6\ J = 1.997 \times 10^9\ J$

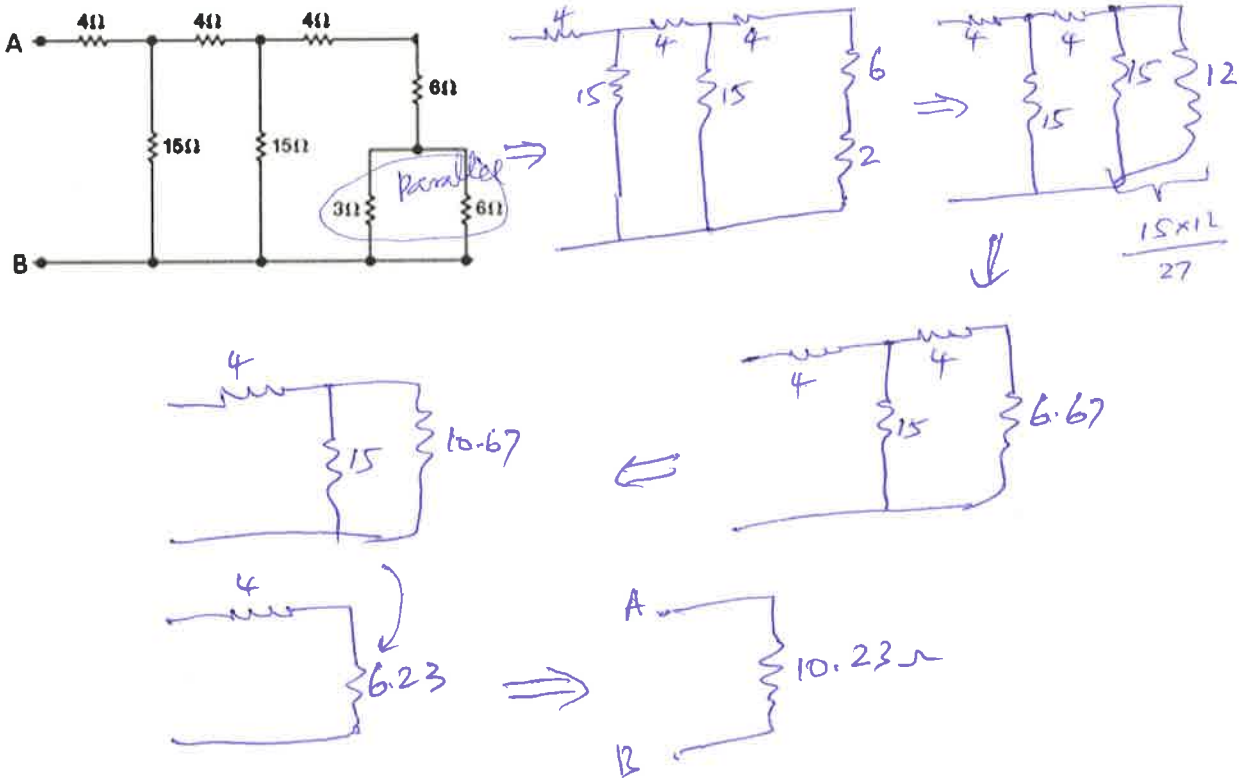
$Q = mc\Delta T + mL_v = 21.5 \times 92.9 \times 10^6$

$m[4186 \times (100 - 17.8) + 2.256 \times 10^6] = 21.5 \times 92.9 \times 10^6$

$m = \frac{21.5 \times 92.9 \times 10^6}{[4186 \times 82.2 + 2.256 \times 10^6]} = 768\ kg$

$m = 768\ kg$

III. Combine all the resistances into a single one, between A & B, for the circuit shown:



IV. A heart defibrillator being used on a patient has an RC time constant of 12.0 ms due to the resistance of the patient and the capacitance of the defibrillator.
(a) If the defibrillator has an 9.00-μF capacitance, what is the resistance of the path through the patient?
(b) If the initial voltage is 14.0 kV, how long does it take to decline to 500 V ?

(a) $RC = 12\,ms = 12\times10^{-3}\,s$

$C = 9.00\times10^{-6}\,F \rightarrow R = \dfrac{12\times10^{-3}}{9\times10^{-6}} = 1333\,\Omega$

$R = 1333\,\Omega$

(b) $V = V_0\, e^{-t/RC}$

$500 = 14\times10^{3}\, e^{-t/RC}$

$\dfrac{500}{14\times10^{3}} = e^{-t/RC} \rightarrow \dfrac{-t}{RC} = \ln\left(\dfrac{500}{14\times10^{3}}\right) = -3.3322$

$t = 39.98\ ms$ & $t = (RC)\times 3.3322$

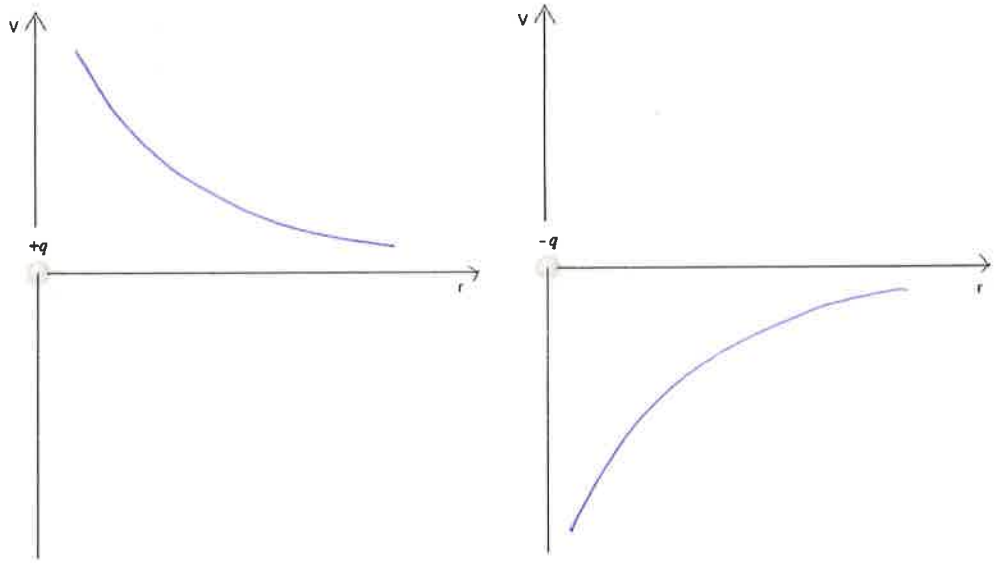
$t = 0.04\,s$

V. At a distance r from a point charge q, the electric potential, V is given by: $V = k\frac{q}{r}$.

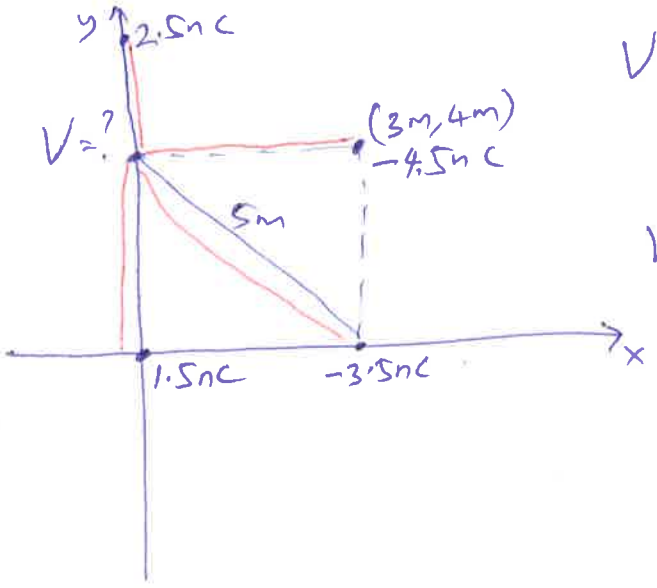
1. Identify electric potential as a vector or scalar and state its SI unit.

Scalar, volt

2. Sketch the electric potential, V as a function of distance for a positive charge and a negative charge below:



3. Four point charges lie in a Cartesian coordinate system as follows:
+1.5nC at (0, 0), –3.5nC at (3 m, 0), 2.5nC at (0, 6 m), and – 4.5nC at (3 m, 4 m). Find the net electric potential at (0, 4 m). Coulomb constant = k = 9 x 10^9 (SI), n = 10^{-9}.



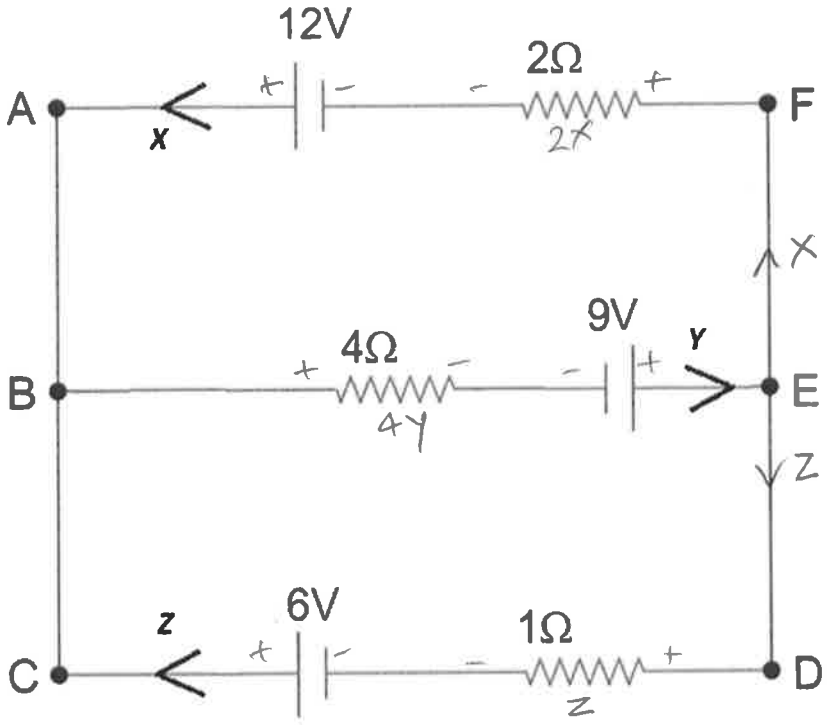
$V = \frac{9\times10^9\times1.5\times10^{-9}}{4} + \frac{9\times10^9\times2.5\times10^{-9}}{2} + \frac{9\times10^9\times(-3.5)\times10^{-9}}{5} + \frac{9\times10^9\times(-4.5)\times10^{-9}}{3}$

$V = 3.375 + 11.25 - 6.3 - 13.5$

$V = -5.175$ volt

$V = -5.175$ V

VI. Kirchhoff's Rules.



Three unknown currents: x, y, and z are identified in the above circuit.

1. Write down the junction rule equation using the assigned currents.

$y = x + z$

2. Identify the low and high potentials for the resistors and batteries.

3. Write down the potential differences across the resistors in terms of the assigned currents and resistances.

4. Write down the loop rule equation, for the top loop, ABEFA, and simplify.

Rise = Drop

$9 + 12 = 4y + 2x$

$21 = 4y + 2x$

5. Write down the loop rule equation, for the bottom loop, BCDEB, and simplify. [no need to solve the equations]

Rise = Drop

$z + 4y = 6 + 9$

$z + 4y = 15$