

Instructions: You have a total of 55 minutes to complete this test.

Answer each question completely showing complete details.

For complete credit you must include correct SI units with numerical answers.

Time Start _____ Time finish _____ pledged _____

Constants: $k = 8.987 \times 10^9 \frac{\text{Nm}^2}{\text{C}^2}$; $\epsilon_0 = 8.854 \times 10^{-12} \frac{\text{C}^2}{\text{Nm}^2}$; $\mu_0 = 4\pi \times 10^{-7} \frac{\text{Tm}}{\text{A}}$

(1) Capacitor 1 has area $A = 0.1 \text{ m}^2$ and a plate separation $d_1 = 0.05 \text{ m}$. Capacitor 2 has an area $A = 0.1 \text{ m}^2$ and a plate separation $d_2 = 0.02 \text{ m}$.

(a) if the two capacitors are placed in series, find the equivalent capacitance.

(b) if the two capacitors are placed in parallel, find the equivalent capacitance.

Resistor 1 has a resistivity $\rho_1 = 100 \Omega \text{ m}$ and a length $L = 0.05 \text{ m}$. Resistor 2 has a resistivity $\rho_2 = 20 \Omega \text{ m}$ and a length $L = 0.02 \text{ m}$. Both resistors have a cross sectional area $A = 0.1 \text{ m}^2$.

(c) If the two resistors are placed in series, find the equivalent resistance.

(d) If the two resistors are placed in parallel, find the equivalent resistance.

(2) Consider the following circuit. Provide the following Kirchoff's laws equations:

(a) loop (abdefgnpa):

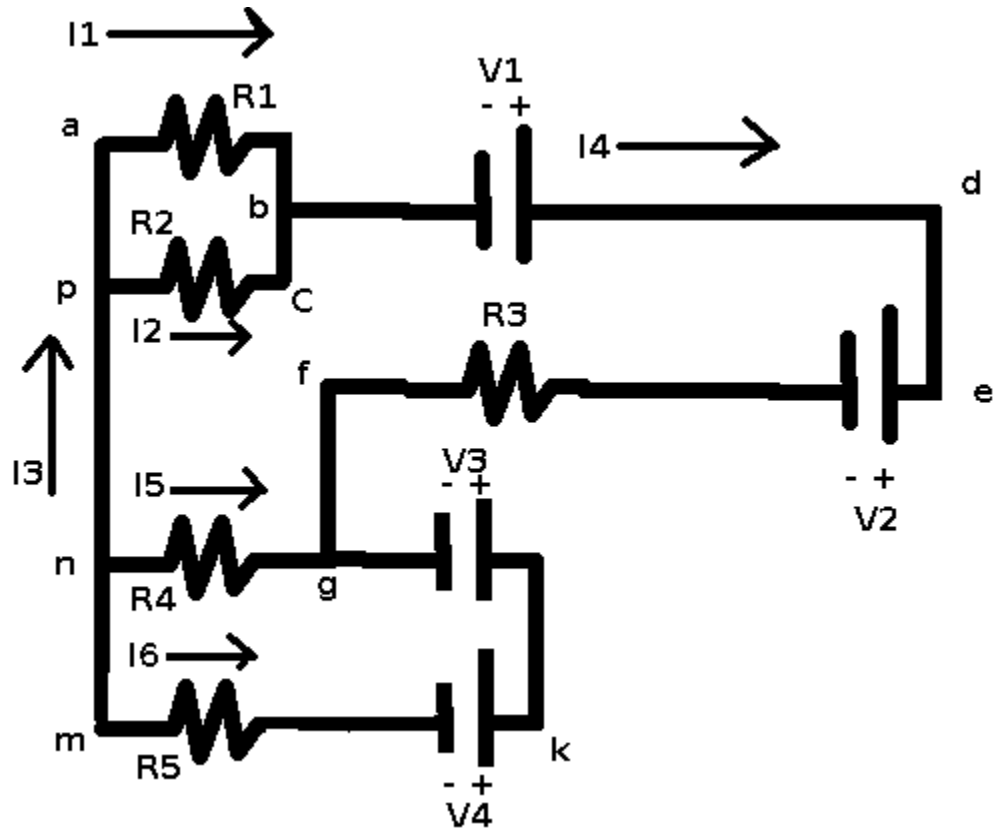
(b) loop (abcpa):

(c) loop (ngkmn):

(d) @ g:

(e) @ p:

(f) @ b:



With $R_1=1, R_2=2, R_3=3, R_4=4, R_5=5, V_1=10, V_2=20, V_3=30, V_4=40$, the following currents result:

$$I_1 = -1.64\text{A} : I_2 = -0.82\text{A} : I_3 = -2.45\text{A} : I_4 = -2.45\text{A} : I_5 = +0.88\text{A} : I_6 = 2.20\text{A}$$

(g) Find power radiated by resistor R_5 .

(h) What is the interpretation of the result provided for current I_2 ?

(3) A parallel plate capacitor has one plate of area A located at $z=0$ and the other plate of area A located at $z=d$. There is a surface charge $+\sigma$ on the plate at $z=0$ and $-\sigma$ on the plate at $z=d$. You may assume that the electric field between the plates is $\vec{E} = \frac{\sigma}{\epsilon_0} \hat{z}$ and zero outside the capacitor.

(a) Calculate the magnitude of the potential difference between the plates.

(b) Calculate the total amount of charge separated, Q in terms of σ and A .

(c) Calculate the capacitance of the parallel plate capacitor in terms of ϵ_0 , A and d .

(d) A capacitor is charged to a maximum charge Q . Find the total energy (U) stored in the capacitor in terms of E , ϵ_0 , A and d .

(e) From your expression for the total stored energy (U) obtained in (d), find an expression for the energy density inside the parallel plate capacitor in terms of ϵ_0 and E .

(4) A wire has a length $L=5$ m and is carrying a current towards the $+x$ direction of 7 A.

(a) Calculate the magnitude of the magnetic field at a distance of 0.1 m from the wire.

(b) Suppose that the same wire, with the same current is subjected to an external magnetic field in the $-y$ direction of strength $B=0.1$ T. Calculate the total **vector force** on the wire (do not forget the direction; $\hat{x}$, $\hat{y}$, or $\hat{z}$).

(c) In a region of space, it is observed that the electric potential varies as:

$V=b+\frac{1}{2}az^2$. Calculate the **vector electric** field in this region of space.