

Mid-term

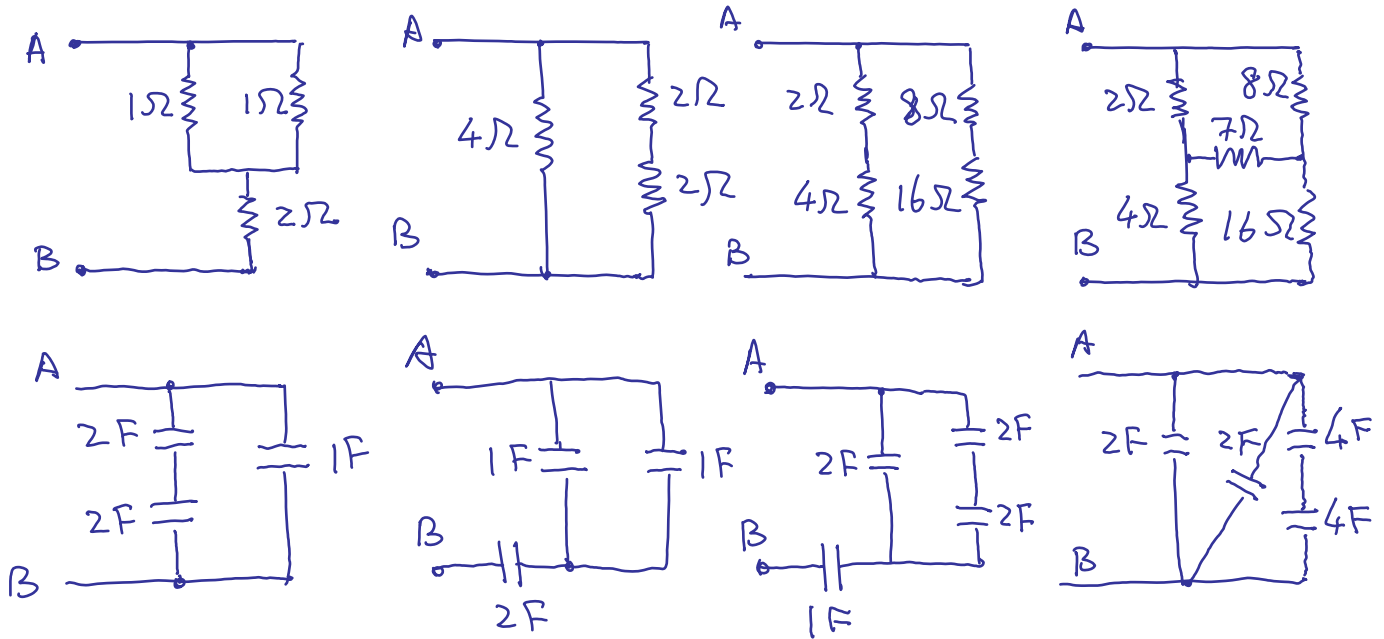
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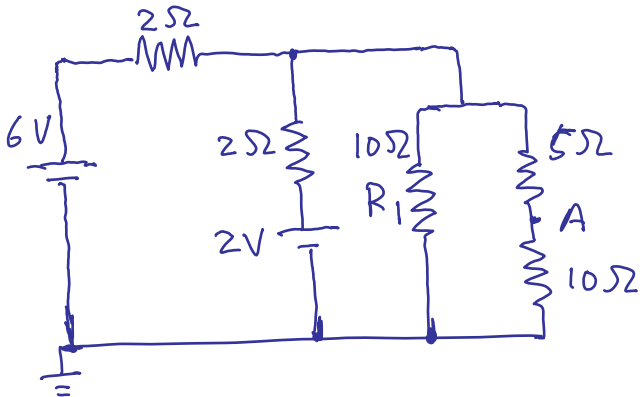
(8 points each question)

1. Charge Q_1 of $\frac{1}{\sqrt{k}}$ is placed 1 meter away from charge Q_2 of $-\frac{1}{\sqrt{k}}$. The quantity k is $8.99 \times 10^9 \text{ Nm}^2/\text{C}^2$, the constant in Coulomb's Law. What is the force on Q_2 ?
2. State Gauss's Law and Ampere's Law in your own language and write out the formulas.
3. State Faraday's Law of induction and write out the formula, and state Lenz Law in your own language.
4. A high voltage generator is made of a metal sphere with a radius of 6 cm sits on an insulating post. A wire connects to the sphere's inner surface through a small hole. The wire carries a current of $1 \mu\text{A}$ and flows into the sphere when the switch is closed. One (1) minute after the switch is closed, what is the electric potential at the surface of the sphere assuming potential far away from the sphere is zero?
5. A straight wire of cross section A and length L has a resistance R and is connected to a battery of emf V , ignore the internal resistance. A certain amount of heat H is generated through the wire every second. When the wire is stretched to twice its length but kept its volume unchanged, what is the heat generated now every second?
6. Inside a conductor the net charge is zero. Use Gauss's Law to prove that the electric field is also zero.
7. Twisted wire pairs are used to reduce interference generated from signal transmission. In each twisted wire pair, the current is the same in magnitude but flows the opposite direction. Use Ampere's Law to prove that the magnetic field generated by this twisted wire pair is zero.
8. In those hard times, people connected two light bulbs in series to prolong the lifetime of them so as to save money on light bulbs. If a person connects two $40\text{W}/220\text{V}$ light bulbs in series to a 220V line, what is the actual power consumed by one light bulb in this configuration? assuming the filament's resistance does not change much with temperature.

9. (16 points) Calculate the effective resistance or capacitance between point A and B.

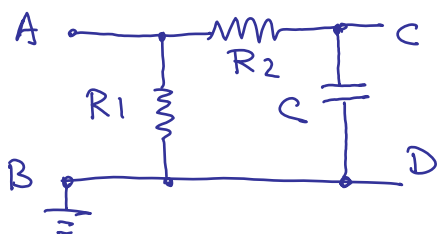


10. (15 points) Calculate the power consumed by R_1 and the potential at point A.



$$R_1 = 10\Omega$$

11. (5 points) An electric pulse of 5V with duration of 1 second is applied at point A and B. calculate the potential difference of C and D (V_{CD}) as a function of time.



$$R_1 = R_2 = 10000\Omega$$

$$C = 10^{-4}F$$

