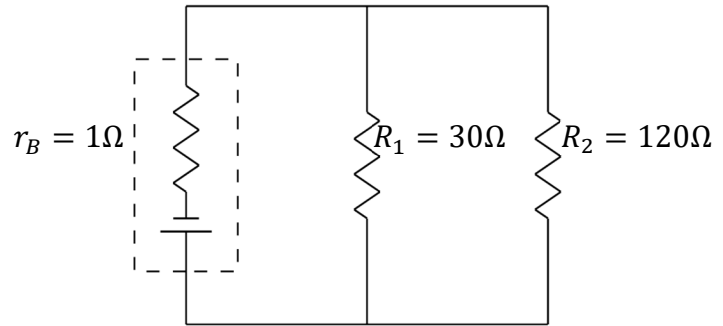For questions 1-5, select the best answer. For problems 6-9, solutions must begin with an Official Starting Equation, when appropriate. Work for problems must be shown and answers provided in the given boxes. Calculators are not allowed.

(8) _____ **1.** A 30 W light bulb and a 60 W are connected in series across a low-voltage power line. Which statement is true?
[A] The two bulbs draw the same current.
[B] The 30 W bulb draws a larger current than the 60 W bulb.
[C] The 60 W bulb draws a larger current than the 30 W bulb.
[D] This question cannot be answered without knowing the value of the voltage.

(8) _____ **2.** A fully charged parallel-plate capacitor is connected to a resistor R to form a resistor-capacitor (RC) circuit. Which of the following is true?
[A] The charge on the plates increases and the voltage across the capacitor increases.
[B] The charge on the plates decreases and the voltage across the capacitor decreases.
[C] The charge on the plates remains constant, but the voltage across the capacitor increases.
[D] The charge on the plates remains constant, but the voltage across the capacitor decreases.

(8) _____ **3.** To build a circuit you need a 1.5-Ohm resistor, but you only have at your disposal a box of 1-Ohm resistors. How do you combine three 1-Ohm resistors to make a 1.5-Ohm resistor?
[A] All three resistors in series.
[B] One resistor in parallel with two resistors connected in series.
[C] One resistor in series with two resistors connected in parallel.
[D] All three resistors in parallel.

(8) _____ **4.** A proton and an electron enter into a region of constant magnetic field $\vec{B}$ with a velocity $\vec{v}$ oriented perpendicular to $\vec{B}$. Which of the following statements describes the circular orbits of the two particles?
[A] The two orbits have the same radius and same direction.
[B] The two orbits have the same radius, but different direction.
[C] The two orbits have different radius, but same direction.
[D] The two orbits have different radius and different direction.

(8) _____ **5** (Free). How many ears does Captain Kirk of the Star Trek Enterprise have:
[A] Two (his left ear and his right ear).
[B] One (only his left ear because a Gorn ate his right ear).
[C] One (only his right ear because a tribble nibbled his left ear).
[D] Three (his left ear, his right ear and his final front ear).

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6. A 10V battery with an internal resistance $r_B = 1.0\Omega$ is connected to two resistors $R_1 = 30\Omega$ and $R_2 = 120\Omega$ as illustrated.

$r_B = 1\Omega$ $R_1 = 30\Omega$ $R_2 = 120\Omega$

(value)   (units)

(10) **(a)** Determine the total resistance of the circuit including the internal resistance of the battery.

(10) **(b)** Determine the total current through the circuit.

(10) **(c)** Determine the current through R_1.

(10) **(d)** Determine the rate at which chemical energy is converted into electrical energy.

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7. A light bulb is connected across a 100V source. When it is first turned on at 20°C it dissipates a power of 100W. After several minutes, the light bulb filament reaches its operating temperature of 3000°C. The light bulb filament has a temperature coefficient of resistivity of $\alpha = 1/2980(°C)^{-1}$. [You may neglect thermal expansion of the filament.]

(value)　　(units)

(8)　(a)　Calculate the initial current passing through the 20°C filament.

(8)　(b)　Calculate the resistance of the 20°C filament

(8)　(c)　Calculate the resistance of the 3000°C filament
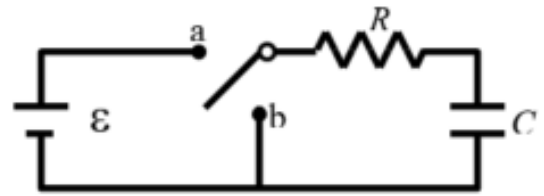
(8)　(d)　Calculate the power dissipated by the 3000°C bulb.

(8)　(e)　Calculate the current passing through the 3000°C filament.

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**8.** In the circuit shown with a resistance R, capacitance C, a switch S, and a battery with an emf $\mathcal{E}$, the capacitor is initially uncharged. Ignore the internal resistance of the battery.

(8) (a) What is the initial current through the resistor immediately after the switch is set to position "*a*"?

(8) (b) What will be the charge on the capacitor a long time after the switch is moved to position "*a*"?

(8) (c) Which of the plots below best represents the charge on the capacitor as a function of time after the switch is moved to position "*a*"? (**circle one**)
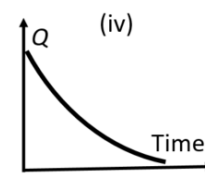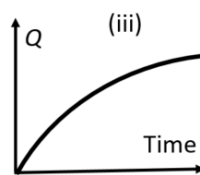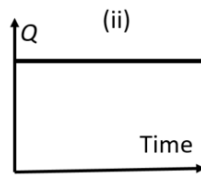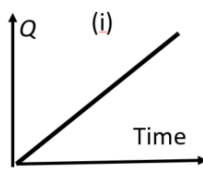

(8) (d) After the capacitor is fully charged, the switch is set to position "*b*". How much time is required for the charge on the capacitor to drop by a factor of $1/e$?

(8) (e) Which of the plots below best represents the voltage across the resistor as a function of time after the switch is set to position "*b*"? (**circle one**)
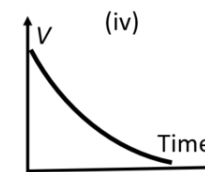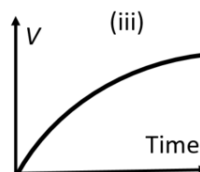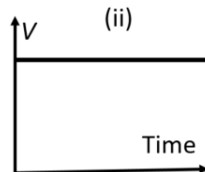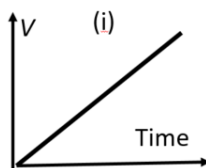
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9. A parallel plate capacitor with a distance L and a capacitance of C is charged with Q. The capacitor is placed in a uniform magnetic field B. An electron (charge $-e$, mass m) enters into the capacitor with a speed of v, and passes undeflected as shown. Express your answers using given symbols.

Capacitor C
$+Q$
Electron
v
$-Q$
L
R
R
Uniform magnetic field
B
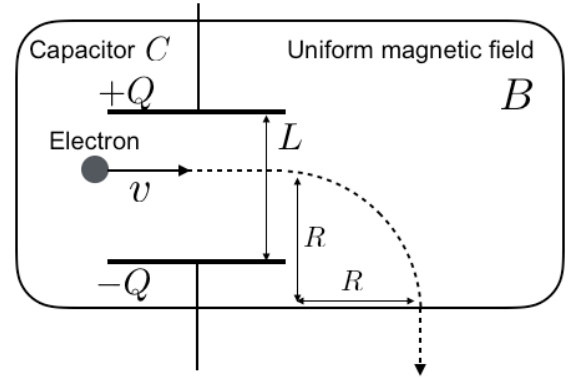
(10) (a) Determine the magnitude and the direction of the electric field in the capacitor.

Direction. Circle one: (up)　(down)　(left)　(right)

(10) (b) Determine the magnitude and the direction of the magnetic force acting on the electron. Express your answer using B.

Direction. Circle one: (up)　(down)　(into the page)　(out of the page)

(10) (c) Determine the magnitude and the direction of the magnetic field. Express your answer using E.

Direction. Circle one: (up)　(down)　(into the page)　(out of the page)

(10) (d) After passing the capacitor, the electron experiences a quarter circular motion as shown. Determine the radius of the motion. Express your answer using B.

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