AP Physics Fall 2013/Spring 2014

Test 17 – Resistance, Capacitance, & DC Circuits

Name: Key

Multiple Choice	(Problems 1- 10)	________	30 pts
Problem 11		________	6 pts
Problem 12		________	6 pts
Problem 13		________	6 pts
Problem 14		________	8 pts
Problem 15		________	12 pts
Problem 16		________	22 pts
Problem 17		________	10 pts
Bonus		________	16 pts
Total		________	

1. When resistors are connected in parallel, we can be certain that

   A. the electric potential difference across each resistor is the same.

   B. their equivalent resistance is greater than the resistance of any one of the individual resistances.

   C. the same current flows in each one.

   D. the power dissipated in each one is the same.

2. If you connect two identical storage batteries together in parallel, and place them in a circuit, the combination will provide

   A. twice the voltage and twice the total charge that one battery would.

   B. half the voltage and half the total charge that one battery would.

   C. the same voltage and twice the total charge that one battery would.

   D. twice the voltage and the same total charge that one battery would.

3. As more and more capacitors are connected in parallel, the equivalent capacitance of the combination increase.

   A. never true

   B. Sometimes true; it depends on the voltage of the battery to which the combination is connected.

   C. Sometimes true; it goes up only if the next capacitor is larger than the average of the existing combination.

   D. always true.

4. Kirchhoff's voltage loop rule is an example of

A. conservation of charge
B. conservation of momentum
C. conservation of energy
D. none of the given answers

5. Car batteries are rated in "amp-hours." This is a measure of their

A. emf
B. charge
C. power
D. current

6. If the voltage across a circuit of constant resistance is doubled, the power dissipated by that circuit will

A. decrease to one half
B. double
C. decrease to one fourth
D. quadruple

$$P = \frac{V^2}{R}$$

7. When two or more capacitors are connected in series to a battery,

A. the equivalent capacitance of the combination is less than the capacitance of any of the capacitors.

B. each capacitor has the same amount of charge.

C. the total voltage across the combination is the algebraic sum of the voltages across the individual capacitors.

D. all of the given answers.

8. A 110-V hair dryer is rated at 1200 W. What current will it draw?

A. 0.090 A   B. 12 A   (C.) 11 A   D. 1.0 A

$P = IV$

$\frac{P}{V} = I = \frac{1200W}{110V} \simeq 11A$

9. Consider two copper wires. One has twice the length of the other. How does the resistances of these two wires compare?

$R = \frac{\rho L}{A}$

(A.) The longer wire has twice the resistance of the shorter wire.

B. The longer wire has half the resistance of the shorter wire.

C. Both wires have the same resistance.

D. none of the given answers

10. Kirchhoff's junction (current) rule is an example of

A. conservation of momentum

(B.) conservation of charge

C. conservation of energy

D. none of the given answers

6 11. A total of 2.0 x 10^{13} protons passes a given point in 15 s. What is the current?

$I = \frac{\Delta Q}{\Delta t}$ (+3)

(+1)

$I = \frac{(2.0 \times 10^{13} \text{ protons})\left(\frac{1.6 \times 10^{-19} C}{1 \text{ proton}}\right)}{15 s} \cong 2.13 \times 10^{-7} A$

or

$0.213 \mu A$

(+1) (+1) units suitable

6 12. If 5.00 A is flowing through a 10.0 Ω resistor. How much power is being dissipated?

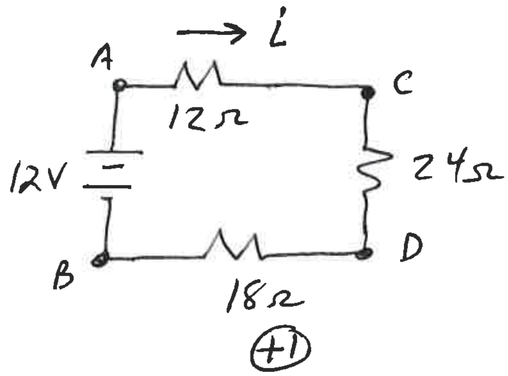
$P = I^2 R$ (+3)

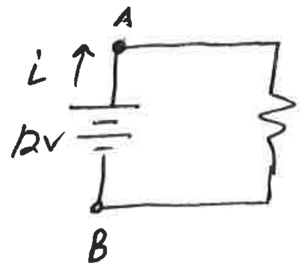
$P = (5A)^2 (10\Omega)$

$P = 250 \text{ W}$

(+2) (+1) units

6 13. Three resistors of 12 Ω, 24 Ω, and 18 Ω are connected in series. A 12-volt battery is connected to the combination. What is the current flowing through the 12 Ω resistor?

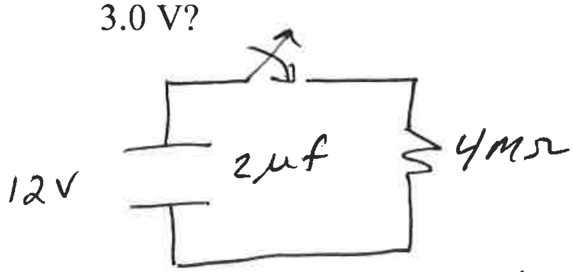




$12\Omega + 24\Omega + 18\Omega = 54\Omega$ (+1) (+1)

$i = \frac{12V}{54\Omega} \cong \boxed{0.222A}$ (+1) (+1) units (+1)

8 14. A 2.0 uF capacitor is charged to 12 V and then discharged through a 4.0 MΩ resistor. How long will it take for the voltage across the capacitor to drop to 3.0 V?



$\tau = RC$ (+1)

$\tau = (2\mu f)(4M\Omega) = 8s$ (+1)

$V = V_0 e^{-t/\tau}$ (+1)

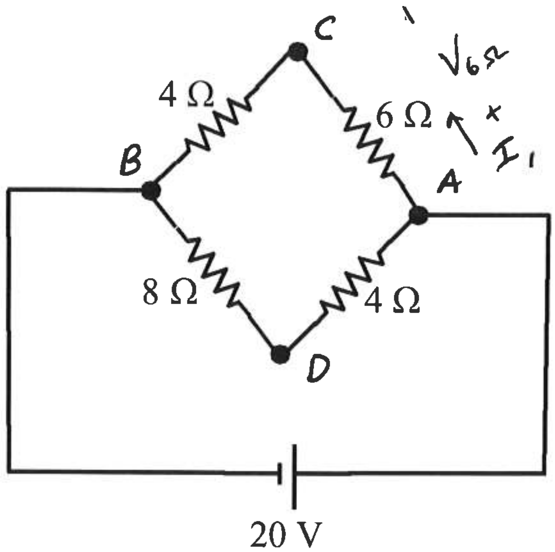
$\ln\left(\frac{V}{V_0}\right) = -t/\tau$ (+1)

(+1) $t = \tau \ln(V_0/V)$

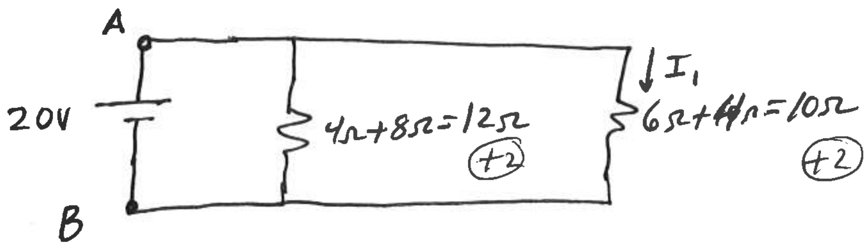
$t \cong (8s)\ln\left(\frac{12V}{3V}\right) \cong \boxed{11.1s}$

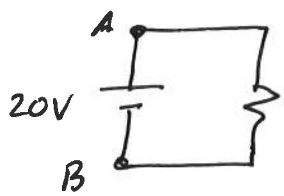
(+2)# (+1) units

1215.



6 A. What is the resistance in the circuit?





$$\frac{(12\Omega)(10\Omega)}{22\Omega} = \frac{60}{11}\,\Omega \cong \boxed{5.45\Omega}$$ (+2)

6 B. What is the voltage across the 6 Ω resistor?

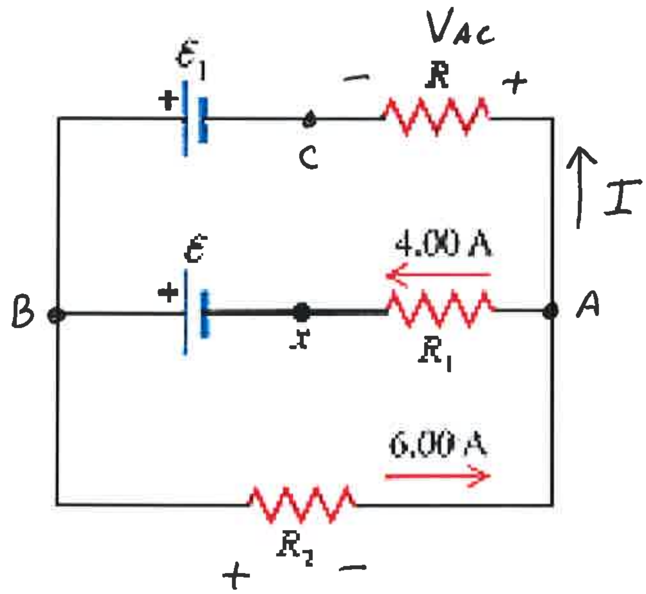
$$I_1 = \frac{V_{AB}}{10\Omega} = \frac{20V}{10\Omega} = 2A$$ (+2) (+1)

$$V_{6\Omega} = I_1(6\Omega) = (2A)(6\Omega)$$ (+1)

$$V_{6\Omega} = \boxed{12 \text{ Volts}}$$

(+1) (+1) units

22 16. In the circuit shown in fig. 27-29, $\varepsilon_1 = 34.0$, $R_1 = 6.00\ \Omega$, and $R_2 = 4.00\ \Omega$.



5 A. Find the current in resistor R.

By KCL at A, we have

$6A - 4A = I$ (+3)

$I = \boxed{2A}$ (+1#) (+1 unit) ← +/- depends on current direction choice.

7 B. Find the resistance R.

$V_{BA} = (6\ A)(4\Omega) = 24\ V$ (+2) Ohm's Law

$V_{BA} = -V_{AC} + \mathcal{E}_1$ (+1) KVL

$V_{BA} = -IR + \mathcal{E}_1$ (+1) ohm's Law

$IR = \mathcal{E}_1 - V_{BA}$

$R = \dfrac{\mathcal{E}_1 - V_{BA}}{I}$ (+1) Algebra

$R = \dfrac{34V - 24V}{2A} = \boxed{5\Omega}$ (+1) # −(+1) unit

C. Find the unknown emf.

5

$$V_{BA} = -(4A)(R_1) + \mathcal{E} \quad (+2) \quad \text{KVL}$$

$$\mathcal{E} = V_{BA} + (4A)(4\Omega) \quad (+1)$$

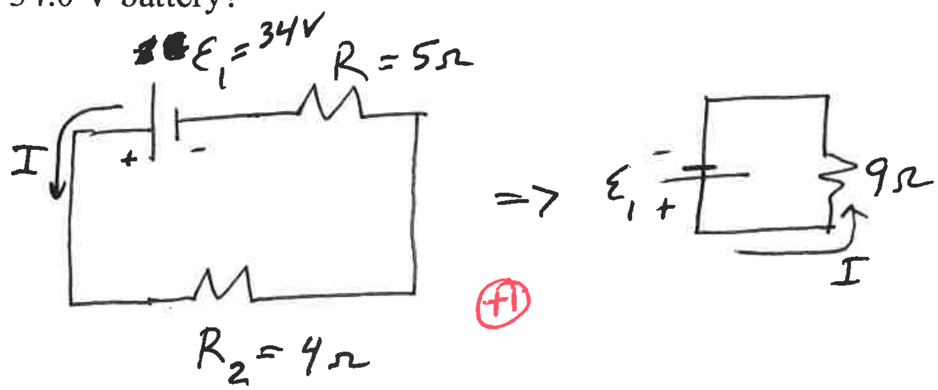
$$\mathcal{E} = 24V + 16V$$

$$\boxed{\mathcal{E} = 40V}$$

(+1) unit

(+1) #

5 D. If the circuit is broken at point x, what is the magnitude of the current in the 34.0 V battery?

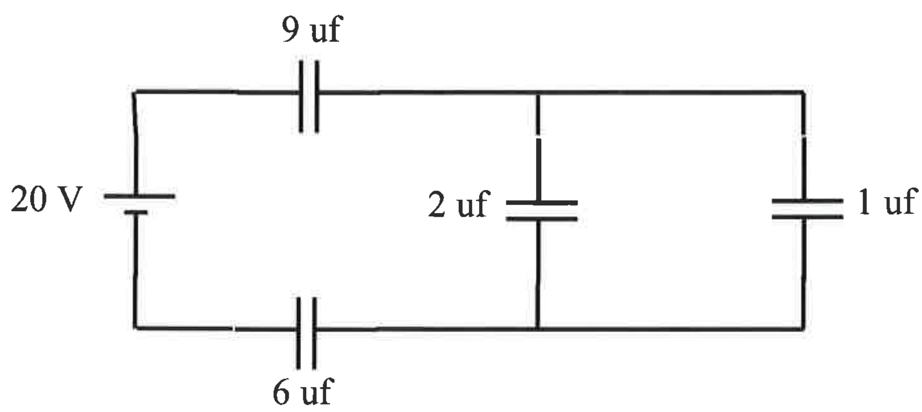


(+1)

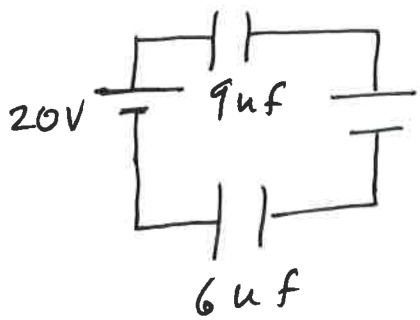
$$I = \frac{\mathcal{E}_1}{9\Omega} = \frac{34V}{9\Omega} = \boxed{6\ A}$$

(+1) (+1) (+1) (+1) unit

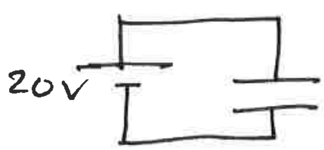
17.



A. What is the total capacitance in the circuit?



$3\,uf = 2uf + 1uf$ (+2)



$$\frac{1}{9uf} + \frac{1}{3uf} + \frac{1}{6uf} = \frac{1}{C}$$ (+1)

$$C \cong 1.64\,uf$$

(+1) units (+1) #

B. What is the charge on the plate of the 6 uf capacitor?

$$Q = CV$$ (+1)

$$Q \cong (1.64\,uf)(20\,v) \cong 32.8\,uC$$

(+1) (+1) (+1 #) (+1 units)

Bonus

9 9 1. Copper has a gram molecular weight of 63.5 g and density of 8.92 g/cm^3. A copper wire of cross section 3.00 x 10^{-6} m^2 carries a current of 10.0 A. Assuming each copper atom contributes two free electrons to the metal, find the drift speed of the electrons in the wire.

$$I = nqA\frac{\Delta x}{\Delta t} \quad (+2)$$

$$I = nqAv_d \quad (+1)$$

$$v_d = \frac{I}{nqA} \quad (+1)$$

$$n = \left(\frac{2\ \text{electrons}}{\text{atom}}\right)\left(\frac{\rho}{GMWt}\right) N_A \quad (+2)$$

$$n = \left(\frac{2\ \text{electrons}}{\text{atom}}\right)\left(\frac{8.92\ \text{g/cm}^3}{63.5\ \text{g/mole}}\right)\left(\frac{6.02\times10^{23}\ \text{atom}}{1\ \text{mole}}\right)$$

$$n \cong 1.69\times10^{23}\ \text{cm}^{-3} \quad (+1)$$

$$v_d \cong \frac{10\ \text{A}}{(1.69\times10^{23}\ \text{cm}^{-3})(1.6\times10^{-19}\ \text{C})(3\times10^{-6}\ \text{m}^2)\left(\frac{100\ \text{cm}}{1\ \text{m}}\right)^2}$$

$$v_d \cong \boxed{0.0123\ \frac{\text{cm}}{\text{s}}} \quad \text{or} \quad 1.23\times10^{-4}\ \frac{\text{m}}{\text{s}}$$

(+1) # (+1) a suitable unit

7 2. You are trying to make a 6.5 mili-ohm resistor out of a cylindrical rod of carbon with a diameter of 8.4 milimeters and resistivity of 3.5 x 10^{-5} Ωm. What length of rod should you cut?

$$R = \frac{\rho L}{A}$$ (+2)

$$L = \frac{RA}{\rho}$$ (+1) $$A = \pi r^2 = \frac{\pi d^2}{4}$$ (+2)

$$L = \frac{(6.5\,m\Omega)(\pi)(8.4\times10^{-3}\,m)^2}{4(3.5\times10^{-5}\,\Omega\cdot m)}$$

$$L \cong 10.3\,mm \cong \boxed{1.03\,cm}$$ (+1) (+1) unit