BioE 1310 - Exam 1 2/10/2011
Answer Sheet - Correct answer is A for all questions

1. The following is *not* true about voltage, or all are true:

A. All are true.

B. It describes the energy required to move a unit charge from one place to another.

C. It is roughly analogous to pressure for water flow.

D. It can be considered for a single point in a circuit only relative to a reference point, normally called ”ground.”

E. When measured across a resistor, it is linearly related to the current through that resistor by Ohm’s law.

Explanation: All are true.
[*circuits0170.mcq*]

2. The power dissipated by a 10 Ω resistor with 5 V across it is

A. 2.5 W

B. 2 W

C. 50 W

D. 20 W

E. Cannot be determined from the data given.

Explanation: Power equals voltage times current, which, in a resistor, equals voltage squared over resistance.
[*circuits0064.mcq*]

3. Multiplying volts $\times$ amperes $\times$ seconds yields units of

A. energy

B. voltage

C. current

D. charge

E. power

Explanation:
1 watt = 1 ampere $\times$ 1 volt
1 joule = 1 watt $\times$ 1 second
[*circuits0196.mcq*]

4. A battery is measured as having a voltage of 9 V without any load attached. Then a 5 Ω resistor is attached across the battery's leads and 5 V is measured across that resistor. What is the internal resistance of the battery?

A. 4 Ω

B. 1 Ω

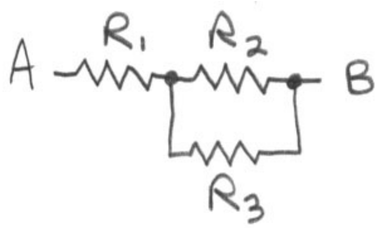
C. 9 Ω

D. 5 Ω

E. cannot be determined

Explanation: With the 5 Ω resistor attached the current is 1 A (because there is 5 V across the resistor). Therefore the remaining 4 volts must be across an internal resistance in the battery of 4 Ω.
[*circuits0090.mcq*]

5. What is the resistance between points A and B, if $R_1 = 200\Omega$, $R_2 = 200\Omega$, and $R_3 = 200\Omega$?



A. 300Ω

B. 600Ω

C. 100Ω

D. 400Ω

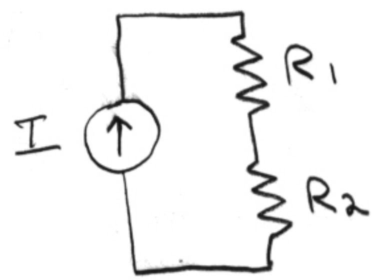
E. None of the other answers is correct.

Explanation:

$$R_1 + \frac{R_2 R_3}{R_2 + R_3}$$

[*circuits0197.mcq*]

6. What is the voltage across R_2 if $R_1 = 30\Omega$, $R_2 = 60\Omega$, and $I = 2mA$?



A. 120 mV

B. 180 mV

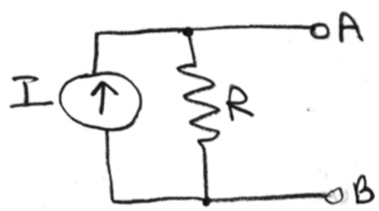
C. 120 V

D. 180 V

E. 30 mV

Explanation: Kirchhoff's Current Law says the same current, I, must pass through both resistors, so the value of R_1 is irrelevant and the voltage across R_2 is simply $I \times R_2$.
[*circuits0198.mcq*]

7. What are the Thevenin equivalent voltage T_V and Thevenin equivalent resistance T_R for the circuit between points A and B, if $R = 10\Omega$ and $I = 5$A?



A. $T_V = 50$V; $T_R = 10\Omega$

B. $T_V = 0.5$V; $T_R = 10\Omega$

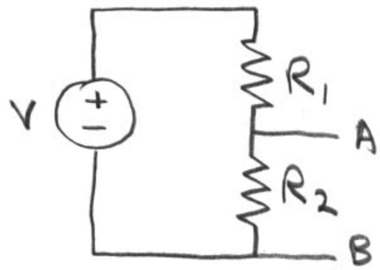
C. $T_V = 2$V; $T_R = 50\Omega$

D. $T_V = 5$V; $T_R = 2\Omega$

E. None of the other answers is correct.

Explanation: T_V is the open circuit voltage, which is $I \times R$. Since the circuit is, itself, the Norton equivalent, the resistance is simply R (the same resistance for both the Thevenin and Norton equivalents. Alternatively, the short circuit current is I, since all of the current will run through the short circuit and none through R, and the Thevenin resistance is $T_V/I = R$.
[*circuits0199.mcq*]

8. What is the voltage between points A and B, if $R_1 = 20\Omega$, $R_2 = 30\Omega$, and V = 15V?



A. 9V

B. 15V

C. 5V

D. 10V

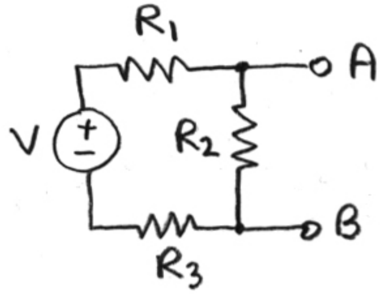
E. 0V

Explanation:

$$V \frac{R_2}{R_1 + R_2}$$

[*circuits0073.mcq*]

9. What is the voltage between points A and B, if $R_1 = 10\Omega$, $R_2 = 20\Omega$, $R_3 = 30\Omega$, and V = 12V?



A. 4 V

B. 3 V

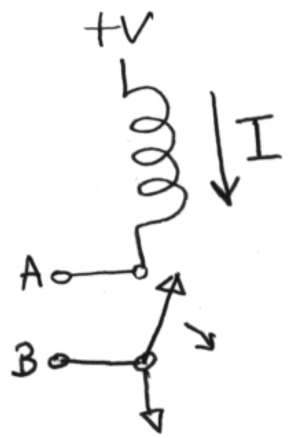
C. 2 V

D. 6 V

E. None of the other answers is correct.

Explanation: The current is $I = \frac{V}{R_1+R_2+R_3}$ and the voltage between A and B is $I \times R_2$.
[*circuits0200.mcq*]

10. Given a current I through this inductor with the switch closed, what voltage would theoretically be generated between A and B if the switch were opened instantly (in zero time)?



A. ∞

B. 0

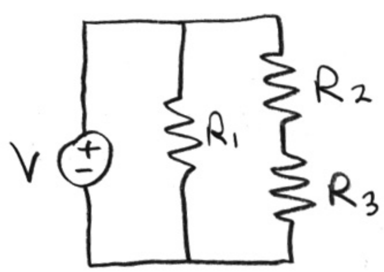
C. I

D. $+V$

E. None of the other answers is correct.

Explanation: ∞ because the voltage across the coil is $L\frac{dI}{dt}$. The current goes from I to 0 instantly, so point A goes to infinity above +V, and therefore point A is also infinity above ground (point B).
[*circuits0201.mcq*]

11. Given that V = 10V, R_1 = 20KΩ, R_2 = 10KΩ, and R_3 = 10KΩ, what is the current through R_1?



A. 500 μA

B. 1 mA

C. 2 mA

D. 1.5 mA

E. 5 mA

Explanation: R_2 and R_3 can be ignored since the same V will be across them (in series) and R_1. So the current through R_1 is simply $I = V/R_1$
[*circuits0202.mcq*]

12. The following is *not* true about current:

A. The sum of the currents around any loop must equal zero.

B. When measured across a resistor, the voltage is linearly related to the current through that resistor.

C. The unit of current is the Ampere, which equals 6.241×10^{18} electrons per second.

D. In general, it can be said to obey Kirchhoff's Current Law, which states that no charge accumulates at any given node in a circuit.

E. Its relationship to voltage across either a capacitor or inductor (coil) takes the form of a first order differential equation with respect to time.

Explanation: The sum a the *voltages* (not the currents) around any loop must equal zero. This is Kirchhoff's voltage law.
[*circuits0203.mcq*]

13. How many joules does a 100 W soldering iron expend in 5 seconds?

A. 500 J

B. 3000 J

C. 20 J

D. 50 mJ

E. Cannot be determined.

Explanation: 1 J = 1 W x 1 sec
[*circuits0204.mcq*]

14. The following are useful tips about safety and electricity, *except*

A. As long as both hands are touching the circuit somewhere, you are safe.

B. Electricity usually kills by effecting the heart, so keep your heart out of the circuit.

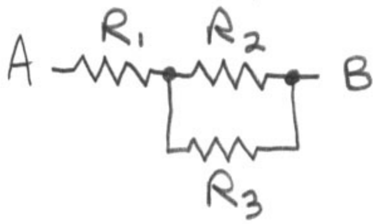
C. Barefoot and dripping from the beach is a bad time to change the lightbulb.

D. Skin resistivity is lowered by water, especially salt water.

E. The green wire in house wiring is supposed to be connected to earth ground as a safety precaution, so that metal cabinets of electronic devices can be safely grounded.

Explanation: Answer A is definitely false. If your each hand touches the circuit, a current could be generated across your heart. Electrocution kills more than 500 people every year in the USA.
[*circuits0205.mcq*]

15. What is the resistance between points A and B, if $R_1 = 20$ MΩ, $R_2 = 20$ MΩ, and $R_3 = 10$ Ω? Calculate only to two significant digits.



A. 20 MΩ

B. 10 Ω

C. 10 MΩ

D. 30 MΩ

E. 40 Ω

Explanation: The total resistance is $R_1 + \frac{R_2 R_3}{R_2 + R_3}$. However, this can be simplified. Because $R_3 << R_2$, R_2 can be ignored, the total resistance becomes $R_1 + R_3$. But it can be simplified even more. Since $R_3 << R_1$, R_3 can be ignored, and the total resistance is simply R_1.
[*circuits0206.mcq*]

16. The following is an appropriate thing to do the digital voltmeter in your PittKit.

A. Measure the voltage across a resistor among a collection of interconnected resistors and a battery plugged into a breadboard using the 'voltage' setting.

B. Measure the resistance across a battery using the 'resistance' setting.

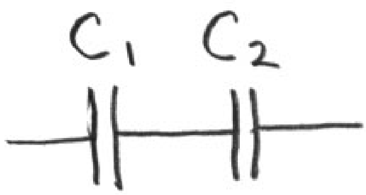
C. Measure the resistance across a capacitor using the 'voltage' setting.

D. Leave the meter in the 'voltage' setting when you put it away at the end of the day.

E. Measure the voltage at one point in a circuit with the red lead, using the 'voltage' setting, leaving the black lead disconnected as a "floating" reference.

Explanation: The "resistance" setting should only be used for measuring passive resistance of a resistor or network of resistors. Our meter does not have an automatic shut-off, so the battery will drain if you don't leave it in the off position (D is wrong). Unless both leads are connected to the circuit, voltage between them is meaningless (E is wrong).
[*circuits0207.mcq*]

17. What is the total capacitance of this branch if $C_1 = 2\ \mu$F, $C_2 = 2\ \mu$F?



A. 1 μF

B. 2 μF

C. 4 μF

D. 0.5 μF

E. None of the other answers is correct.

Explanation: Capacitances in series add like resistors in parallel. In other words, $C_S = \frac{C_1 \times C_2}{C_1 + C_2}$.
[*circuits0208.mcq*]

18. The property of *inductance* in a coil may best be described as follows:

A. The magnetic field surrounding a current contains energy, and it requires a voltage applied over time to change that energy.

B. The mass of the electrons provides inertia, which makes them want to keep moving in a given direction.

C. The current in a coil is proportional to the voltage across the coil over the resistance of the coil.

D. The buildup of charge on one section of the coil is offset by the depletion of charge on a neighboring section of the coil.

E. The magnetic field within the coil is non-linear with respect to the magnetic field of the earth.

Explanation: Answer B is the actual inertia of the electrons, an insignificant factor. Answer C is simply Ohm's law, accounting for the coil's *resistance*, not its inductance. Answers D describes capacitance. Answer E is not related to inductance.
[*circuits0178.mcq*]

19. Which of the following is *false* about permittivity (or all are true)?

A. It permits a constant current to leak between the plates of the capacitor.

B. Even free space has a non-zero permittivity.

C. It can be increased by the alignment of charges in the material between the plates of a capacitor.

D. All are true.

E. In a given capacitor, it determines the capacitance for a given area of plates and distance between them.

Explanation: A capacitor may leak, but not because of permittivity. Permittivity relates to the storage capacity for charge between the plates due to the material between them.
[*circuits0152.mcq*]

20. The millihenry is

A. a certain amount of inductance, which results in 1 volt when changing the current at a rate of 1 ampere/millisecond.

B. a certain amount of inductance, which results in 1 kilovolt when changing the current at a rate of 1 ampere/second.

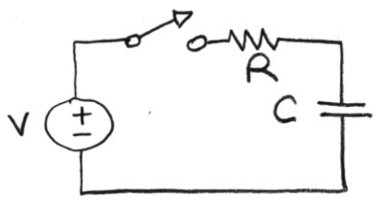
C. a certain amount of inductance, equivalent to 1000 henries.

D. a certain strength of magnetic field.

E. a certain amount of inductance, which results in 1 volt after charging a capacitor for 1 second at 1 mA..

Explanation: A millihenry is 1/1000 of a henry, the unit of inductance, relating voltage to the rate of change of current in an inductor, $V = L\frac{dI}{dt}$.
[*circuits0146.mcq*]

21. What equation describes the voltage on the capacitor $V_C(t)$ after the switch is closed at $t = 0$, given the capacitor is completely discharged beforehand, i.e., $V_c(0) = 0$? (Ignore the equation's behavior for $t < 0$).



A. $V_C(t) = V\left(1 - e^{-\frac{t}{RC}}\right)$

B. $V_C(t) = \left(1 - e^{-\frac{t}{RC}}\right)$

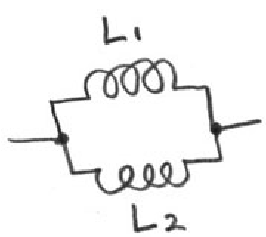
C. $V_C(t) = V\left(e^{-\frac{t}{RC}}\right)$

D. $V_C(t) = V \times \frac{C}{R+C}$

E. Cannot be determined with the information given.

Explanation: This is the solution to the differential equation given by $I(t) = \frac{V - V_C(t)}{R}$ and $I(t) = C\frac{dV_C(t)}{dt}$. It is also the only choice that behaves appropriately; it starts at 0V and approaches the voltage V.
[*circuits0138.mcq*]

22. If $L_1 = 300$ mH, $L_2 = 600$ mH , the circuit below is equivalent to



A. a single 200 mH inductor.

B. a 900 mA current source.

C. a single 900 mH inductor.

D. a single 300 mH inductor.

E. none of the other answers.

Explanation: Inductors add in parallel as resistors do: $L_{parallel} = \frac{1}{\frac{1}{L_1} + \frac{1}{L_2}}$.
[*circuits0144.mcq*]

23. The energy stored in a 3 Henry inductor (coil) with 4 A through it

A. is 24 J.

B. equals the heat dissipated by the coil.

C. is 12 J.

D. cannot be determined without more information.

E. depends on how long it took to achieve the current.

Explanation: The energy is due to the magnetic field and is independent of how long it took to achieve the current. The energy is proportional to the square of the current for a given inductance, $E = \frac{1}{2}LI^2$. The heat given off is due to the resistance of the coil, not the inductance.
[*circuits0209.mcq*]

24. Two resistors are in parallel with 20 V across both of them. Each resistor is 10 KΩ. What is the current through *one* of the resistors?

A. 2 mA

B. 1 mA

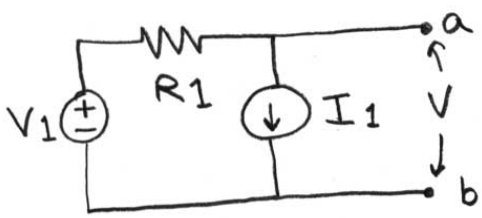
C. 5 mA

D. 4 mA

E. Cannot be determined from the data given.

Explanation: Since the same voltage is across each of the resistors, Ohm's law applies to each independently. The current through either of the resistors is 2 mA.
[*circuits0065.mcq*]

25. What is the voltage between points a and b, given that $R_1 = 5\Omega$, $V_1 = 10$V, and $I_1 = 1$A?



A. 5 V

B. 10 V

C. 15 V

D. 0 V

E. None of the other answers is correct.

Explanation: Using Kirchoff's current law, the current through the entire loop must be I_1. Using Kirchoff's voltage law, the voltage between points a and b is $V_1 - I_1R_1$.
[*circuits0176.mcq*]