Circuit Lab Free Response

Directions: You will be given 40 minutes to complete the following written portion of the Circuit Lab exam. The following page contains some helpful formulas that you may use throughout the test. There are a lot of problems in this test and you may not finish them all. Do not worry about completing the test; answer as many questions are you can without losing accuracy. The test contains multiple choice questions, fill in the blank, and free response questions. Note that the free response is weighted higher than the rest of the questions. Additionally, the last free response question is **extra credit** so it is in your best interest to attempt that question.

Calculators: Per Science Olympiad guidelines, you are not allowed to use any version of the TI-83, TI 84, TI 89, or TI*nspire* on this exam.

Team Members: _____ _____

Team Type: JV V

Exam Number (from M/C booklet): **KEY**

_____**Do not write in this section**_____

Team Multiple Choice: _____**23**_____+

Team Free Response: _____**85**_____+

Team Extra Credit: _____**+29 Possible**_____=

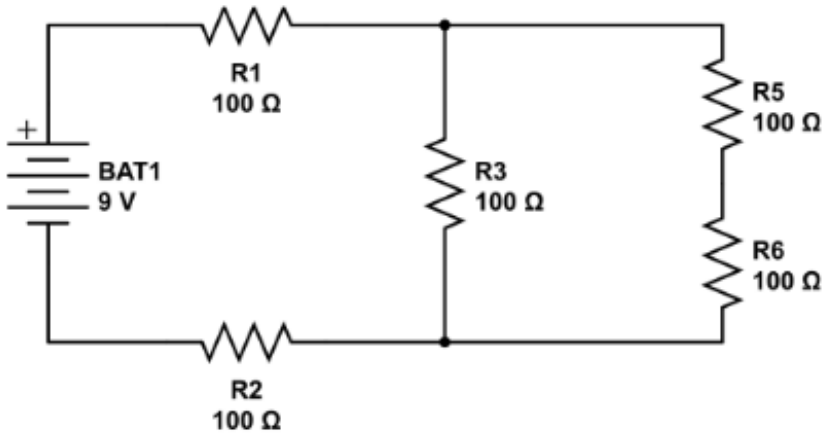
Team Total Score: _____

Team Placement: _____

FREE RESPONSE QUESTIONS

Directions: Show all of your work to these questions. Most are worth more than one point and the work accounts for most of the points. Since this competition is based upon total points, it is in your best interest to attempt every question! If you cannot think of anything to solve the problem, try to write down some equations to earn partial credit.

Circuit 1 (Questions 1-6)



27. What is the equivalent resistance in the circuit?

V=IR
$R_{par}+R_{series}=R_{TOTAL}$ **+1 Work, +1 Answer, +1 Units**
R_T= 267 Ohms

28. Is this circuit a series, parallel, or combination circuit?

Combination **+1**

29. Will the current going through R3 be greater than, less than, or equal to the current through R5? Why?

Greater Than, there is only one resistor in the branch and, by Kirchhoff's law, voltage in each branch must be the same. **+2**

30. Would the equivalent resistance increase, decrease, or stay the same if R3 was replaced with a wire?

Decrease **+1**

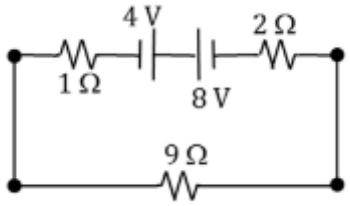
31. What is the voltage across R3?

V=IR **+1 Work, +1 Answer, +1 Units**

2.25 Volts

32. How much power is dissipated by R3?

50.6 mW **+1 Work, +1 Answer, +1 Units**



Use with questions 33-34

33. What type of circuit is shown above?
    a. **Series**
    b. Parallel
    c. Combination
    d. None of the above

Write your justification here: **Current only has one way to travel**

+4 (+2 ans, +2 justification)

34. Find the current in the circuit above.

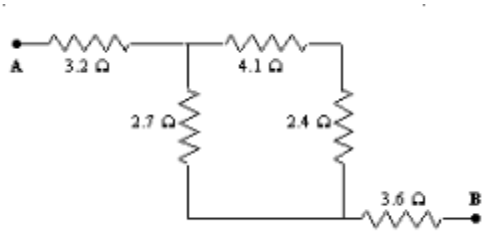
V=IR
Rtotal= 2+9+1= 12 Ohms
Vtotal= 12 Volts
Itotal= .3333 amps

+1 Work, +1 Answer, +1 Units

35. In any given circuit, what is the direction of current in relation to the flow of electrons?

Opposite **+2**

36. Five resistors are connected as shown in the diagram. The potential difference between points and A and B is 15 V.



a. What is the current in the 2.7 ohm resistor?

Rt= 8.707 ohms
Itotal= 1.722 A
V= IR
V=3.2(1.722A)
V1=5.51
I1= 1.344A

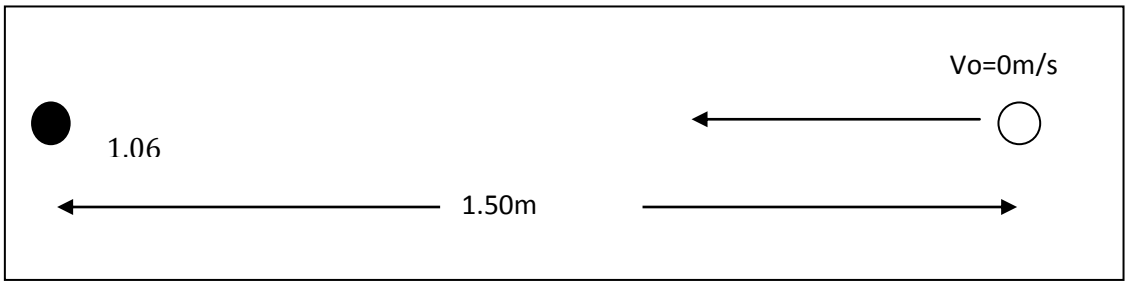
+2 Work, +1 Answer, +1 Units

37. Draw a parallel-series circuit that correctly uses the following elements in schematic form.
    a. Light bulb (1)
    b. Resistor (3)
    c. Wire (No Limit)
    d. 6.6V battery (1)
    e. Buzzer (schematic symbol is a circle with B in it) (1)

ANSWERS WILL VARY.
Parallel Series: +3
Schematic Form: +3
Resistors: +3
Light bulb: +2
Buzzer: +1
Voltage Source: +2

+14 Total

38. The following system had one charge (of +1.06C) at a fixed position) Then, a charged electron (charge -1.602x 10^{-19} C and mass 9.109 x 10^{-31}kg) is placed in the system. Calculate the final velocity of the electron at the second it approaches the +1.06C charge. Assume gravity is negligible and that there are no other charges present in the system. You may assume the track to be frictionless. (Hint: Use the formulas given and draw a (Free Body) force diagram! Circle your object!)



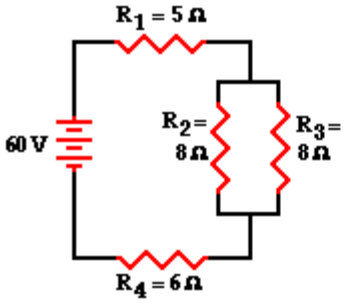
+12

Answer: **V_f= 4.727 m/s**

39. According to the equation $F_e = \frac{kq1q2}{d^2}$, k is a proportionality constant while *q1* and *q2* are charges (measured in coulombs). Constant k is known to be 9x10^9, but it also has some unit. Using the equation and what you know about electricity, find the unit of constant k. Remember that distance is always measured in meters and forces are measured in Newtons for all physics problems.

Answer: **Jm/C**
Or **Nm^2/C**

40. Given the following circuit and equation V=IR, find:
Show all of your work CLEARLY!



R_{tot} = 15 Ω I_{tot} = 4 Amp

I_1 = 4 Amp ΔV_1 = 20 V

I_2 = 2 Amp ΔV_2 = 16 V

I_3 = 2 Amp ΔV_3 = 16 V

I_4 = 4 Amp ΔV_4 = 24 V

41. Fill in the Blank—Choose the correct answer to put in the blank. You may circle your answers.

a. The current at location A is **equal to** the current at location B.

b. The current at location B is **greater than** the current at location E.

c. The current at location G is **less than** the current at location F.

d. The current at location E is **greater than** the current at location G.

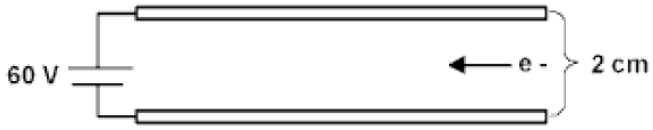
e. The current at location B is **greater than** the current at location F.

f. The current at location A is **equal to** the current at location L.

g. The current at location H is **less than** the current at location I.

42. ***EXTRA CREDIT:***

Two parallel plates have a potential difference of 60V and are separated by a distance of 2 cm. An electron is fired into the plates with a horizontal trajectory half way between the plates (1cm) at an initial velocity of $3x10^6$ m/s. How fast will the electron be moving when it hits the positive plate? You may ignore the effects of gravity and assume the track to be frictionless. **Include all units and show all of your work!**



Equations for this Problem:

$\Delta v = Ed$

$F_e = qE$

$v = qEd$

Where

$v =$ Voltage (Electric Potential), $E =$ Field Strength (N/C), $q =$ Charge of object, $d =$ Distance

Charge of an Electron: $-1.6 * 10^{-19}$ C

Mass of an Electron: $9.10 * 10^{-31}$ kg