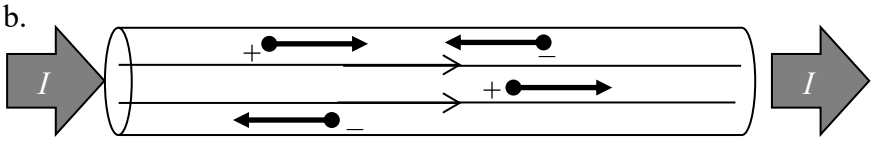
AP Physics C Assignment Complete Answers – Current and Circuits

1. a. 0.26 A
   b.
   

   c. 1.9×10^{19}
2. 6.0 minutes
3. a. 17 kC
   b. 410 C
4. a. 50 V, 100 V, 150 V
   b. 150 V, 300 V, 450 V
5. a. 0.051 Ω
   b. 140 Ω
   c. 0.035%
6. a. 27 mA
   b. 17 V
7. a. 28 Ω, 32 Ω
   b. The bulb is nonohmic as shown by the fact that its resistance increased significantly as the current was increased and its temperature increased.
   c. The increase in temperature is the cause of increased resistance as it affects the condition of the atoms through which electrons must travel.
8. a. The filament can carry only so much current before it will essentially melt at a weak point. If the current is great enough the filament breaks.
   b. Because resistance increases with temperature, the current through the bulb is least when the temperature is greatest and vice versa.
   c. At the instant a bult is turned on, the filament of the bulb is at a relatively cool room temperature and therefore has a minimum amount of resistance. Accordingly the initial current through the bulb is greater than the amount of current that occurs at a period of time later once the temperature of the filament has increased to its "operating level".
9. a. 0.11 Ω
   b. 0.11 mm
10. a. To double the resistance of a resistor the length of the cylinder should be doubled. This is because resistance of a cylinder is directly proportional to its length.
    b. Doubling the diameter would cause resistance do drop to one fourth its original value. Resistance is inversely proportional to cross-sectional area. Doubling the diameter causes the area to quadruble.
11. a. 8.02 Ω/km
    b. 2.41 V
12. Al dia. = 1.26 time Cu
13. a. $9.96 \times 10^{5}\ \Omega^{-1}m^{-1}$
    b. $1.00 \times 10^{-6}\ \Omega m$
    c. nichrome

14. a. 3.8×10^5 A/m^2
    b. 4.0×10^{-5} m/s
    c. 10 h
    d. 9.1 mV
15. a. 0.084 V/m
    b. 4.8 A, 0.25 V
    c. 3.6×10^{-4} m/s
16. a. 0.0167 Ω
    b. 0.0063 V/m
    c. 3.7×10^5 A/m^2
17. a. 3.0 kW
    b. 4500 J
    c. 380 C
18. a. 0.8 A
    b. 0.2 ns
19. a. 3.6 MJ
    b. 30 kC
    c. 8 A
20. a. 18 kW
    b. 24 A
21. a. 0.33 A
    b. 18 Ω
    c. 3.6 h
    d. 4300 C
    e. 26 kJ
22. a. 570 Ω
    b. 82.5 Ω
23. possibilities:
    a. 105 Ω
    b. 55.0 Ω
    c. 279 Ω or 563 Ω
24. a. $4R/7$
    b. $R/2$
25. a. 0.19 mA
    b. 0.23 V
    c. 0.24 mW (R_2)
26. a. 1.5 mA
    b. 0.22 mA
    c. 1.9 mW (R_1)
27. a. 20.4 mA
    b. 2.04 V
    c. 8.42 mA
    d. 47.5 mW

28. a. 26.7 mA
    b. 1.40 V
    c. 12.8 mA
    d. 64.3 mW
29. a. 2.56 mW
    b. 0.507 mA
    c. 50.7 mV
    d. the 330 Ω
    (0.958 mW)
30. a. The resistor at the top of the diagram will have the greatest current because it is connected directly to the voltage source. Each other path in the circuit has multiple voltage drops occurring such the source voltage is divided up. Therefore each of these resistors will has less voltage and less current. The diagonal resistors all have the same amount of current, which is the least that occurs. Going around the outer edge it can be seen that the source voltage is split in two by the two vertical resistors. But each diagonal path splits this voltage in two again, such that the diagonal resistors each have one fourth the current as the resistor at the top of the diagram.
    b. The resistor in the center of the diagram has the greatest current because it is connected directly to the voltage source. Each other resistor is in a path that divides the source voltage into two equal parts. Therefore all of the diagonal resistors each have half the current as the center resistor.
31. a. 0.126 W
    b. 14.0 mA, left
    c. –5.96 V
32. a. 780 Ω
    b. 1.7
33. a. 0.720 W, 0.115 W,
    0.0800 W
    b. 0.720 W, 0.0238 W,
    0.00 W
34. a. 1.8 A
    b. –1.5 A
    c. –14 V
35. a. –0.070 A, 0.34 A
    b. 0.42 W absorbed,
    4.1 W produced
    c. 1.8 W, 1.9 W,
    0.059 W
36. a. 0.0743 A, –0.176 A,
    –0.676 A, 0.176 A
    b. 4.91 Ω, 11.2 Ω

37. a. In normal operation the shunt path should have more resistance so that essentially all of the current goes through the filament, causing it to light up.
    b. 9.6 Ω, 2.4 V, 0.25 A
    c. Immediately after the break there is much less current in the string of lights because the overall resistance is much greater with the gap in the filament. With very little current through the extinguished bulbs there is very little voltage across all of the other bulbs and essentially 120 volts across the bulb with the broken filament.
    d. The voltage across the shunt is greater when the filament breaks than when the filament is glowing, as explained above. In normal operation there is only a couple of volts and this does not affect the resistive coating.
    e. When the shunt "heals the circuit" the remaining bulbs can once again illuminate. However, there can be a very slight difference because in the brightness, current, and voltage of each remaining bulb if the resistance of the "healed shunt" is not the same as the resistance of a single filament.
38. a. $4V^2$/R, V^2/R
    b. $UR/(2V^2)$, $2UR/V^2$
    c. Connect in series provides greater voltage, which results in greater current, and therefore also greater power and a brighter bulb. However, the downside is that the energy of the cells will be depleted much more rapidly.
39. a. 0.30 W, 0.079 W
    b. 96%, 99%
40. a. 26.4 mA
    b. 1.38 V
    c. 12.6 mA
    d. 62.6 mW
41. one solution uses a
    211 Ω resistor
42. a. 0.69 A
    b. 63 J
    c. 51%
    d. Charge the battery by using a source that is closer to the emf of the rechargeable cell. In so doing there will be less current and therefore less power loss due to resistance. However, it will take longer to fully recharge.
43. a. $P_{max} = \varepsilon^2 R\, r^{-2}$
    b. 180 W
    c. 986
    d. The efficiency would decrease as the number of cells in the stack increases. This is because greater and greater current through the additional cells will increase the rate and amount of heat generated by resistance.
44. a. 42.0 kΩ, schematic
    b. 8.08 mΩ, schematic
45. a. 1050 Ω
    b. 10000 Ω/V
    c. 1.04 Ω

46. a. 0.114 A, 11.4 V
(11.4286)

b. 0.104 A

c. 11.4 V (11.4231)

d. 8.7%, 0.05%

e. If the 100-ohm resistor is replaced by a much greater resistance then the ammeter may end up being more accurate than the voltmeter! Adding the resistance of the ammeter to the circuit will have less of an impact and have a negligible effect on current through the loop if the resistor is much greater. If the resistor has a resistance comparable to that of the voltmeter then a significant amount of current will be "split off" into the voltmeter. The equivalent resistance of the resistor-voltmeter combination will be significantly less than the resistor by itself and therefore the voltage drop will be significantly changed. (For example with a 5000 Ω resistor the percent errors will be 0.30% for the ammeter and 0.35% for the voltmeter.)