ANSWERS - AP Physics Multiple Choice Practice – Circuits

	Solution	Answer
1.	The resistances are as follows: I: 2 Ω, II: 4 Ω, III: 1 Ω, IV: 2 Ω	B
2.	The total resistance of the 3 Ω and 6 Ω in parallel is 2 Ω making the total circuit resistance 6 Ω and the total current $\mathcal{E}/R$ = 1 A. This 1 A will divide in the ratio of 2:1 through the 3 Ω and 6 Ω respectively so the 3 Ω resistor receives 2/3 A making the potential difference IR = (2/3 A)(3 Ω) = 2 V.	B
3.	Adding resistors in parallel decreases the total circuit resistance, this increasing the total current in the circuit.	A
4.	$R = \rho L/A$. Greatest resistance is the longest, narrowest resistor.	B
5.	In parallel $V_1 = V_2$. $Q_1 = C_1V_1$ and $Q_2 = C_2V_2$ so $Q_1/Q_2 = C_1/C_2 = 1.5$	D
6.	For steady power dissipation, the circuit must allow current to slow indefinitely. For the greatest power, the total resistance should be the smallest value. These criteria are met with the resistors in parallel.	D
7.	To retain energy, there must be a capacitor that will not discharge through a resistor. Capacitors in circuits C and E will discharge through the resistors in parallel with them.	B
8.	$P = I\mathcal{E}$	C
9.	$W = Pt = I^2Rt$	B
10.	The resistance of the two 2 Ω resistors in parallel is 1 Ω. Added to the 2 Ω resistor in series with the pair gives 3 Ω	A
11.	$R = \rho L/A$. Least resistance is the widest, shortest resistor	E
12.	The resistance of the two resistors in parallel is r/2. The total circuit resistance is then 10 Ω + ½ r, which is equivalent to $\mathcal{E}/I$ = (10 V)/(0.5 A) = 20 Ω = 10 Ω + r/2	E
13.	Resistance varies directly with temperature. Superconductors have a resistance that quickly goes to zero once the temperature lowers beyond a certain threshold.	C
14.	The loop rule involves the potential and energy supplied by the battery and it's use around a circuit loop.	B
15.	The capacitance of the 4 μF and 2μF in parallel is 6 μF. Combined with the 3μF in series gives 2 μF for the right branch. Added to the 5 μF in parallel gives a total of 7 μF	D
16.	Since the 5 μF capacitor is in parallel with the battery, the potential difference across it is 100 V. Q = CV	B
17.	Total circuit resistance (including internal resistance) = 40 Ω; total current = 0.3 A. $\mathcal{E} = IR$	D
18.	$V_{XY} = \mathcal{E} - Ir$ where r is the internal resistance	C
19.	$P = I^2r$	A
20.	With more current drawn from the battery for the parallel connection, more power is dissipated in this connection. While the resistors in series share the voltage of the battery, the resistors in parallel have the full potential difference of the battery across them.	B
21.	Amperes = I (current); Volts = V (potential difference); Seconds = t (time): IVt = energy	C

22. Resistance of the 1 Ω and 3 Ω in series = 4 Ω. This, in parallel with the 2 Ω resistor gives $(2 \times 4)/(2 + 4) = 8/6\ \Omega$. Also notice the equivalent resistance must be less than 2 Ω (the 2 Ω resistor is in parallel and the total resistance in parallel is smaller than the smallest resistor) and there is only one choice smaller than 2 Ω. A

23. The upper branch, with twice the resistance of the lower branch, will have ½ the current of the lower branch. C

24. Power = IV = 480 W = 0.48 kW. Energy = Pt = (0.48 kW)(2 hours) = 0.96 kW-h D

25. Total circuit resistance of the load = R/2. Total circuit resistance including the internal resistance = r + R/2. The current is then $\mathcal{E}/(r + R/2)$ and the total power dissipated in the load is $P = I^2R_{load} = (\mathcal{E}^2R/2)/(r + R/2)^2$. Using calculus max/min methods or plotting this on a graph gives the value of R for which this equation is maximized of R = 2r. This max/min problem is not part of the B curriculum but you should be able to set up the equation to be maximized. D

26. The larger loop, with twice the radius, has twice the circumference (length) and $R = \rho L/A$ D

27. By process of elimination, A is the only possible true statement. A

28. $R = \rho L/A$. If L ÷ 2, R ÷ 2 and is r ÷ 2 then A ÷ 4 and R × 4 making the net effect R ÷ 2 × 4 B

29. The motor uses P = IV = 60 W of power but only delivers P = Fv = mgv = 45 W of power. The efficiency is "what you get" ÷ "what you are paying for" = 45/60 E

30. Resistance of the 2000 Ω and 6000 Ω in parallel = 1500 Ω, adding the 2500 Ω in series gives a total circuit resistance of 4000 Ω. $I_{total} = I_1 = \mathcal{E}/R_{total}$ D

31. I_1 is the main branch current and is the largest. It will split into I_2 and $I_3$and since I_2 moves through the smaller resistor, it will be larger than I_3. A

32. $P = V^2/R$ E

33. The current through R is found using the junction rule at the top junction, where 1 A + 2 A enter giving I = 3 A. Now utilize Kirchhoff's loop rule through the left or right loops: (left side) + 16 V – (1 A)(4 Ω) – (3 A)R = 0 giving R = 4 Ω B

34. Utilizing Kirchhoff's loop rile with any loop including the lower branch gives 0 V since the resistance next to each battery drops the 2 V of each battery leaving the lower branch with no current. You can also think of the junction rule where there is 0.04 A going into each junction and 0.04 A leaving to the other battery, with no current for the lower branch. D

35. Summing the potential differences from left to right gives V_T = –12 V – (2 A)(2 Ω) = – 16 V. It is possible for $V_T > \mathcal{E}$. E

36. Current is greatest where resistance is least. The resistances are, in order, 1 Ω, 2 Ω, 4 Ω, 2 Ω and 6 Ω. A

37. See above E

38. Least power is for the greatest resistance ($P = \mathcal{E}^2/R$) E

39. In series, the equivalent capacitance is calculated using reciprocals, like resistors in parallel. This results in an equivalent capacitance smaller than the smallest capacitor. D

40. $V_T = \mathcal{E} - Ir$ C

41. Kirchhoff's junction rule applied at point X gives 2 A = I + 1 A, so the current in the middle wire is 1 A. Summing the potential differences through the middle wire from X to Y gives – 10 V – (1 A)(2 Ω) = –12 V D

42. When the switch is closed, the circuit behaves as if the capacitor were just a wire and all the potential of the battery is across the resistor. As the capacitor charges, the voltage changes over to the capacitor over time, eventually making the current (and the potential difference across the resistor) zero and the potential difference across the capacitor equal to the emf of the battery. A

43. See above A

44. See above B

45. In series $\frac{1}{C_T} = \sum \frac{1}{C}$ B

46. There are several ways to do this problem. We can find the total energy stored and divide it into the three capacitors: $U_C = \frac{1}{2} CV^2 = \frac{1}{2} (2\ \mu F)(6\ V)^2 = 36\ \mu J \div 3 = 12\ \mu J$ each C

47. $P = I^2R$ and $R = \rho L/A$ giving $P \propto \rho L/d^2$ C

48. $P = I^2R$ D

49. Since these resistors are in series, they must have the same current. E

50. Each branch, with two capacitors in series, has an equivalent capacitance of $2\ \mu F \div 2 = 1\ \mu F$. The three branches in parallel have an equivalent capacitance of $1\ \mu F + 1\ \mu F + 1\ \mu F = 3\ \mu F$ C

51. For each capacitor to have 6 μC, each *branch* will have 6 μC since the two capacitors in series in each branch has the same charge. The total charge for the three branches is then 18 μC. $Q = CV$ gives $18\ \mu C = (3\ \mu F)V$ C

52. Utilizing Kirchhoff's loop rule starting at the upper left and moving clockwise: $-(2\ A)(0.3\ \Omega) + 12\ V - 6\ V - (2\ A)(0.2\ \Omega) - (2A)(R) - (2A)(1.5\ \Omega) = 0$ A

53. Summing the potential differences: $-6\ V - (2\ A)(0.2\ \Omega) - (2A)(1\ \Omega) = -8.4\ V$ C

54. Energy $= Pt = I^2Rt$ C

55. When the switch is closed, the circuit behaves as if the capacitor were just a wire, shorting out the resistor on the right. B

56. When the capacitor is fully charged, the branch with the capacitor is "closed" to current, effectively removing it from the circuit for current analysis. A

57. Total resistance $= \mathcal{E}/I = 25\ \Omega$. Resistance of the 30 Ω and 60 Ω resistors in parallel = 20 Ω adding the internal resistance in series with the external circuit gives $R_{total} = 20\ \Omega + r = 25\ \Omega$ C

58. $P = V^2/R$ and if V is constant $P \propto 1/R$ A

59. For the ammeter to read zero means the junctions at the ends of the ammeter have the same potential. For this to be true, the potential drops across the 1 Ω and the 2 Ω resistor must be equal, which means the current through the 1 Ω resistor must be twice that of the 2 Ω resistor. This means the resistance of the upper branch (1 Ω and 3 Ω) must be ½ that of the lower branch (2 Ω and R) giving $1\ \Omega + 3\ \Omega = \frac{1}{2}(2\ \Omega + R)$ E

60. Kirchhoff's loop rule ($V = Q/C$ for a capacitor) B

61. To dissipate 24 W means $R = V^2/P = 6\ \Omega$. The resistances, in order, are: 8 Ω, 4/3 Ω, 8/3 Ω, 12 Ω and 6 Ω E

62. Dimensional analysis: $1.6 \times 10^{-3}\ A = 1.6 \times 10^{-3}\ C/s \div 1.6 \times 10^{-19}\ C/proton = 10^{16}$ protons/sec $\div 10^{9}$ protons/meter $= 10^{7}$ m/s D

63. The equivalent capacitance of the two 3 μF capacitors in parallel is 6 μF, combined with the 3 μF in series gives $C_{total} = 2\ \mu F$ B

64. The equivalent capacitance between X and Y is twice the capacitance between Y and Z. This means the voltage between X and Y is ½ the voltage between Y and Z. For a total of 12 V, this gives 4 V between X and Y and 8 V between Y and Z. D

65. Closing the switch short circuits Bulb 2 causing no current to flow to it. Since the bulbs were originally in series, this decreases the total resistance and increases the total current, making bulb 1 brighter. B

66. In series $\frac{1}{C_T} = \sum \frac{1}{C}$ E

67. $P = V^2/R$ C

68. Closing the switch reduces the resistance in the right side from 20 Ω to 15 Ω, making the total circuit resistance decrease from 35 Ω to 30 Ω, a slight decrease, causing a slight increase in current. For the current to double, the total resistance must be cut in half. B

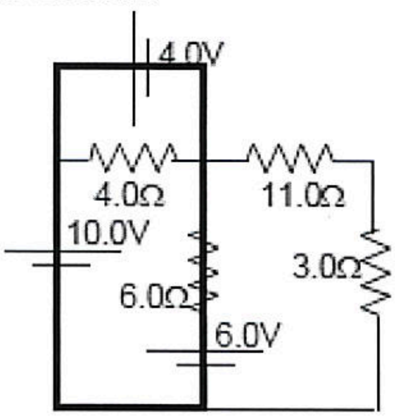
69. $R = \rho L/A \propto L/d^2$ where d is the diameter. $R_x/R_y = L_x/d_x^2 \div L_y/d_y^2 = (2L_y)d_y^2/[L_y(2d_y)^2] = ½$ B

70. Using all three in series = 3 Ω, all three in parallel = 1/3 Ω. One in parallel with two in series = 2/3 Ω, one in series with two in parallel = 3/2 Ω C

71. Summing the potential differences from bottom to top:
left circuit: $-(1\text{ A})r + \mathcal{E} = 10$ V
right circuit: $+(1\text{ A})r + \mathcal{E} = 20$ V, solve simultaneous equations C

72. The equivalent resistance of the 20 Ω and the 60 Ω in parallel is 15 Ω, added to the 35 Ω resistor in series gives 15 Ω + 35 Ω = 50 Ω D

73. If you perform Kirchhoff's loop rule for the highlighted loop, you get a current of 0 A through the 6 Ω resistor. A



74. N is in the main branch, with the most current. The current then divides into the two branches, with K receiving twice the current as L and M. The L/M branch has twice the resistance of the K branch. L and M in series have the same current. D

75. See above. Current is related to brightness ($P = I^2R$) D

76. If K burns out, the circuit becomes a series circuit with the three resistors, N, M and L all in series, reducing the current through bulb N. E

77. If M burns out, the circuit becomes a series circuit with the two resistors, N and K in series, with bulb L going out as well since it is in series with bulb M. E

78. Using Kirchhoff's loop rule around the circuit going through either V or R since they are in parallel and will have the same potential drop gives: $-V - (1.00 \text{ mA})(25\ \Omega) + 5.00\text{ V} - (1.00 \text{ mA})(975\ \Omega) = 0$ D

79. The equivalent resistance in parallel is smaller than the smallest resistance. A

80. When the capacitor is fully charged, the branch on the right has no current, effectively making the circuit a series circuit with the 100 Ω and 300 Ω resistors. $R_{total} = 400\ \Omega$, $\mathcal{E} = 10\text{ V} = IR$ C

81. In series, they all have the same current, 2 A. $P_3 = I_3V_3$ C

82. $P = \mathcal{E}^2/R$. Total resistance of n resistors in series is nR making the power $P = \mathcal{E}^2/nR = P/n$ D

83. The current through bulb 3 is twice the current through 1 and 2 since the branch with bulb 3 is half the resistance of the upper branch. The potential difference is the same across each branch, but bulbs 1 and 2 must divide the potential difference between them. E

84. by definition of a parallel circuit E

85. $R = \rho L/A \propto L/d^2$ where d is the diameter. $R_{II}/R_I = L_{II}/d_{II}^2 \div L_I/d_I^2 = (2L_I)d_I^2/[L_I(2d_I)^2] = ½$ C

86. $P = IV$ A

87. If the current in the 6 Ω resistor is 1 A, then by ratios, the currents in the 2 Ω and 3 Ω resistor are 3 A and 2 A respectively (since they have 1/3 and 1/2 the resistance). This makes the total current 6 A and the potential drop across the 4 Ω resistor 24 V. Now use Kirchhoff's loop rule for any branch. D

88. The voltage across the capacitor is 6 V ($Q = CV$) and since the capacitor is in parallel with the 300 Ω resistor, the voltage across the 300 Ω resistor is also 6 V. The 200 Ω resistor is not considered since the capacitor is charged and no current flows through that branch. The 100 Ω resistor in series with the 300 Ω resistor has 1/3 the voltage (2 V) since it is 1/3 the resistance. Kirchhoff's loop rule for the left loop gives $\mathcal{E} = 8$ V. C

89. $P = V^2/R$ D

90. For the currents in the branches to be equal, each branch must have the same resistance. C

91. $R \propto L/A = L/d^2$. If $d \times 2$, $R \div 4$ and if $L \div 2$, $R \div 2$ making the net effect $R \div 8$ A

92. Bulbs in the main branch have the most current through them and are the brightest. D

93. In parallel, all the resistors have the same voltage (2 V). $P_3 = I_3V_3$ D

94. If the resistances are equal, they will all draw the same current. A

95. Resistor D is in a branch by itself while resistors A, B and C are in series, drawing less current than resistor D. D

96. Even though the wires have different resistances and currents, the potential drop across each is 1.56 V and will vary by the same gradient, dropping all 1.56 V along the same length. E

97. Each computer draws $I = P/V = 4.17$ A. 4 computers will draw 16.7 A, while 5 will draw over 20 A. D

98. The capacitance of the two capacitors in parallel is 2C. Combined with a capacitor in series gives $C = \frac{C \times 2C}{C+2C} = \frac{2}{3}C$ B

99. $P = IV = 1.56$ kW. Energy $= Pt = 1.56\text{ kW} \times 8\text{ h} = 12.48$ kW-h D

100. Resistance of bulbs B & C = 20 Ω combined with D in parallel gives 6.7 Ω for the right side. Combined with A & E in series gives a total resistance of 26.7 Ω. $\mathcal{E} = IR$ B

101. A and E failing in the main branch would cause the entire circuit to fail. B and C would affect each other. A

102. $V = IR$ A

103. $\mathcal{E} = IR_{total}$ where $R_{total} = 35\ \Omega$ D

104. With the switch closed, the resistance of the 15 Ω and the 30 Ω in parallel is 10 Ω, making the total circuit resistance 30 Ω and $\mathcal{E} = IR$ D

105. $P = I^2R$ B

106. The equivalent resistance through path ACD is equal to the equivalent resistance through path ABD, making the current through the two branches equal E

107. The resistance in each of the two paths is 9 Ω, making the current in each branch 1 A. From point A, the potential drop across the 7 Ω resistor is then 7 V and across the 4 Ω resistor is 4 V, making point B 3 V lower than point C D

108. Since the volume of material drawn into a new shape in unchanged, when the length is doubled, the area is halved. $R = \rho L/A$ E

109. Closing the switch reduces the total resistance of the circuit, increasing the current in the main branch containing bulb 1 A

110. *Resistivity* is dependent on the material. Not to be confused with *resistance* C

111. Resistors J and N are in the main branch and therefore receive the largest current. D

112. $P = I^2R$ D

113. Breaking the circuit in the lower branch lowers the total current in the circuit, decreasing the voltage across R_1. Looking at the upper loop, this means R_2 now has a larger share of the battery voltage and the voltage across AD is the same as the voltage across BC A

114. In series circuits, larger resistors develop more power B

115. With a total resistance of 10 Ω, the total current is 1.2 A. The terminal voltage $V_T = \mathcal{E} - Ir$ C

116. Most rapid heating requires the largest power dissipation. This occurs with the resistors in parallel. E

117. $P = IV$ D

118. Shorting bulb 3 decreases the resistance in the right branch, increasing the current through bulb 4 and decreasing the total circuit resistance. This increases the total current in the main branch containing bulb 1. C

119. The total charge to be distributed is $+100\ \mu C - 50\ \mu C = +50\ \mu C$. In parallel, the capacitors must have the same voltage so the 20 μF capacitor has four times the charge of the 5 μF capacitor. This gives $Q_{20} = 4Q_5$ and $Q_{20} + Q_5 = 4Q_5 + Q_5 = 5Q_5 = 50\ \mu C$, or $Q_5 = 10\ \mu C$ E

120. The equivalent resistance of the two 4 Ω resistors on the right is 2 Ω making the total circuit resistance 10 Ω and the total current 2.4 A. The 2.4 A will divide equally between the two branches on the right. $Q = It = (1.2\ A)(5\ s) = 6\ C$ E

121. For more light at a given voltage, more current is required, which requires less resistance. $R = \rho L/A$ B

122. Bulb C in the main branch receiving the total current will be the brightest C

123. Wire CD shorts out bulb #3 so it will never light. Closing the switch merely adds bulb #2 in parallel to bulb #1, which does not change the potential difference across bulb #1. C

124. 1 year = 365 days × 24 hours/day = 8760 hours. W (energy) = Pt = 0.1 kW × 8760 hours = 867 kW-h × \$0.10 per kW-h = \$ 86.7 — C

125. For points a and b to be at the same potential, the potential drop across the 3 Ω resistor must be equal to the potential drop across capacitor C. The potential drop across the 3 Ω resistor is three times the drop across the 1 Ω resistor. For the potential drop across capacitor C to be three times the crop across the 1 μF capacitor, C must be 1/3 the capacitance, or 1/3 μF — A

126. In parallel $\frac{1}{R_T} = \sum \frac{1}{R}$ — B

127. Shorting bulb 4 decreases the resistance in the right branch, increasing the current through bulb 3 and in the main branch containing bulb 1. — D

128. R = V/I where V = W/Q and Q = It giving R = W/I^2t and W = joules = kg m^2/s^2 — A

129. If A were to burn out, the total resistance of the parallel part of the circuit increases, causing less current from the battery and less current through bulb A. However, A and B split the voltage from the battery in a loop and with less current through bulb A, A will have a smaller share of voltage, increasing the potential difference (and the current) through bulb B. — C

130. When the current is 0.5 A, the voltage across the resistor is V = IR = 5 V. According to the loop rule, the remaining 7 V must be across the capacitor. — D

131. When the switch has been closed a long time, the voltage across the capacitor is 10 V as the current has stopped and the resistor has no potential drop across it. $U_C = \frac{1}{2} CV^2$ — D

132. Since there is constant current, bulb 1 remains unchanged and bulbs 2 and three must now split the current. With half the current through bulb 2, the potential difference between A and B is also halved. — D

133. The voltmeter is essentially another resistor. The voltmeter in parallel with the 100 Ω resistor acts as a 500 Ω resistor, which will half ½ the voltage of the 100 Ω resistor on the left. Thus the 120 V will split into 80 V for the 1000 Ω resistor and 40 V for the voltmeter combination. — D

134. $P = I^2R$ and the current is the same through each resistor. — A

135. The greatest current is in the main branch. — A

136. Let the current through the 1 Ω be x. The potential difference across the 1 Ω resistor is then x volts. The current will divide between the upper branch (5 Ω) and the lower branch (9 Ω) with (using the current divider ratio method) 9/(9 + 5) = 9/14 x in the upper branch and 5/14 x in the lower branch. The potential differences are then IR giving for the 2, 3, 4, 5 Ω resistors, respectively 18/14 x, 27/14 x, 20/14 x and 25/14 x volts. — C

137. The 15 Ω resistor would be in parallel with the 30 Ω resistor when the switch is closed. — C

138. ACD = 9 Ω, ABD = 9 Ω so the total resistance is 4.5 Ω making the total current $\mathcal{E}/R$ = 2 A. — A

139. The 2 A will divide equally between the two branches with 1 A going through each branch. From B to D we have – (1 A)(2 Ω) = –2 V, with B at the higher potential — A

140. When the capacitor is charged, the branch is effectively removed from the circuit, making it a simple parallel circuit. The total resistance is 133.3 Ω and V = IR — C

141. In a simple series circuit with two batteries opposing one another the voltages subtract from one another. The total effective voltage for this circuit is then 4 V. With a total resistance of 20 Ω the total current is (4 V)/(20 Ω) — E

142. For no current to flow, the potential drop across R_1 must equal the potential drop across R_2. For this to occur $I_1R_1 = I_2R_2$. Since the two branches also have the same potential difference as a whole (they are in parallel) we also have $I_1(R_1 + R_3) = I_2(R_2 + R_4)$. Solve for R_3 D

143. When the capacitor is charged, the branch is effectively removed from the circuit, making the circuit a 10 Ω resistor in series with two 10 Ω resistors in parallel. The lone 10 Ω resistor has twice the voltage of the two 10 Ω resistors in parallel with an effective resistance of 5 Ω. The 10 volts will then divide with 3.3 V going to the parallel combination and 6.7 V going to the single 10 Ω resistor. The capacitor is in parallel with the single 10 Ω resistor. Q = CV C

144. The resistances are, respectively, 4/3 R, 2/5 R, R, and 5/3 R A

145. Closing the switch adds another parallel branch, increasing the total current delivered by the battery. Bulb 3 will get brighter. Bulb 2, in its own loop with bulb 3 and the battery will then lose some of its share of the potential difference from the battery and will get dimmer. C

146. For the 3 capacitors in series on the right $C_T = C/3$. Adding to the capacitor in parallel gives $C + C/3 = 4C/3$ C

147. Superconductors have a property where the resistance goes to zero below a certain threshold temperature. A

148. On the right, the 6 Ω and 3 Ω resistor in parallel have an equivalent resistance of 2 Ω. Added to the 4 Ω resistance in the middle branch which is in series with the pair gives 6 Ω across the middle. This is in parallel with the 3 Ω resistor at the top giving an equivalent resistance of 2 Ω. Lastly add the 4 Ω resistor in the main branch giving a total circuit resistance of 6 Ω. V = IR. D

149. Using ratios, the currents in the 6 Ω and 3 Ω resistors are 1 A and 2 A. They have three times and 3/2 times the resistance of the 2 Ω resistor so they will have 1/3 and 2/3 the current. The total current is then 6 A giving a potential drop of 36 V across the 6 Ω resistor in the main branch and adding any one of the branches below with the loop rule gives 36 V + 6 V = 42 V for the battery B

150. Voltmeters must be placed in parallel and ammeters must be placed in series. B

151. Even though B_2 burns out, the circuit is still operating elsewhere as there are still closed paths. B

152. With B_2 burning out, the total resistance of the circuit increases as it is now a series circuit. This decreases the current in the main branch, decreasing V_1. For V_1 to be halved, the current must be halved which means the total resistance must be doubled, which by inspection did not happen in this case (total before = 5/3 R, total after = 3 R) D

153. S_1 must be closed to have any current. Closing S_2 will allow current in R_2 but closing R_3 would short circuit R_2. C

154. S_1 must be closed to have any current. Closing S_3 will short circuit R_3, leaving only resistor R_1, which is the lowest possible resistance. E

155. S_1 must be closed to have any current. The greatest voltage will occur with the greatest current through R_3 but closing S_2 or S_3 will draw current away from R_3. A

156. $R = \rho L/A$ D

157. Starting at A and summing potential differences *counterclockwise* to point C gives 12 V A

158. The branch with two 2 Ω resistors has a total resistance of 4 Ω and a potential difference of 12 V. V = IR C

159. For the 6 μF and 3 μF capacitor in series, the equivalent capacitance is 2 μF. Adding the 2 μF in parallel gives a total capacitance of 4 μF D

160. In series the capacitors have the same charge, but the smaller capacitor will have the larger potential difference (to force the same charge on a smaller area) C

161. Before cutting the resistance is R. After cutting we have two wires of resistance ½ R which in parallel is an equivalent resistance of ¼ R. $P = V^2/R$ and $I = V/R$ E

162. $P = V^2/R$ and $R = \rho L/A$ giving $P = V^2A/\rho L$ B

163. 1 kW-h = 1000 W × 60 min = 60,000 W-min = $I^2Rt = I^2(20\ \Omega)(30\ \text{min})$ A

1976B3

a. $V_T = E - Ir = 6$ V

b. In parallel, each resistor gets 6 V and $P = V^2/R$ gives $R = 3\ \Omega$

c. For the 3 Ω resistor we have $I = V/R = 2$ A leaving 1 A for the branch with R_1. $R = V/I = 6\ \Omega$

1981B4

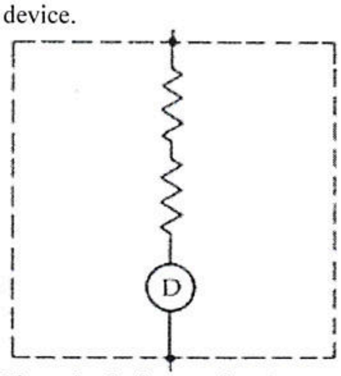
a. The two batteries are connected with opposing emfs so the total emf in the circuit is $\mathcal{E} = 60\text{ V} - 12\text{ V} = 48$ V
The resistance of the parallel combination of resistors is $(\frac{1}{4} + \frac{1}{4} + \frac{1}{2})^{-1} = 1\ \Omega$ combining with the rest of the resistors in series gives a total circuit resistance of 8 Ω.
The total current is then $\mathcal{E}/R = 6$ A. The voltage across the parallel combination of resistors is $V_P = IR_P = 6$ V so the current through the 2 Ω resistor is $I = V/R = 3$ A

b. $P = I^2R = 108$ W

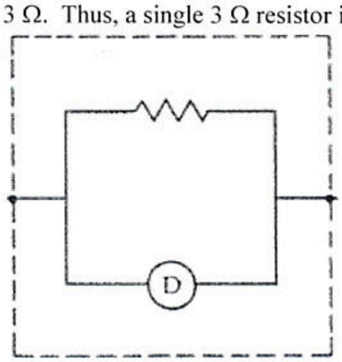
c. The current is forced through battery Bfrom the positive to the negative terminal, charging the battery. This makes the equation for the terminal voltage $V_T = \mathcal{E} + Ir = 18$ V

1980B2

a. The resistance of the device is found from $R = V/I = 6\ \Omega$. With a 24 volt source, to provide a current of 2 A requires a total resistance of 12 Ω. For the additional 6 Ω resistance, place two 3 Ω resistors in series with the device.



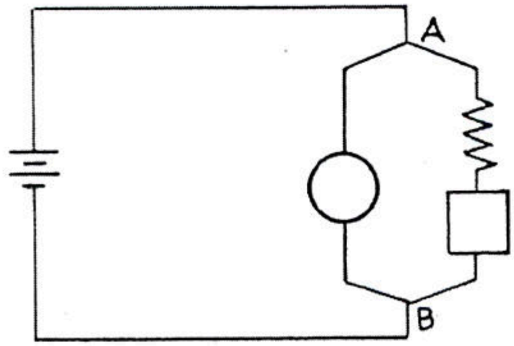
b. Since the device requires 2 A, a resistor in parallel with the device must carry a current of $6\text{ A} - 2\text{ A} = 4$ A. In parallel with the device, the resistor will have a potential difference of 12 V so must have a resistance of V/I = 3 Ω. Thus, a single 3 Ω resistor in parallel will suffice.



c. $P = I^2R = 48$ W

1982B4

a. Since the clock requires 15 V it must be directly connected between A and B. Since the radio requires less than 15 V, there must be a resistor in series with it.



b. The current through the radio (and R) is 10 mA. The voltage across the radio is 9 V, which leaves 6 V across the resistor giving R = V/I = 600 Ω

c. P = IV where V = 15 V and I = 10 mA + 20 mA = 30 mA so P = 0.45 W and energy = Pt = 27 J

1983B3

a. The two batteries are connected with opposing emfs so the total emf in the circuit is $\mathcal{E}$ = 20 V – 2 V = 18 V
The equivalent resistance of the two parallel resistors is (6 × 12)/(6 + 12) = 4 Ω and since R is in series with the pair, the total circuit resistance is (4 + R) Ω = $\mathcal{E}$/I = 9 Ω giving R = 5 Ω

b. Because the voltages of the two resistors in parallel are equal we have $6I_1 = 12I_2$ and $I_1 + I_2$ = 2 A giving
   i. 4/3 A
   ii. 2/3 A

c. Summing the potential differences form point X gives V_X + IR = 0 + (2 A)(5 Ω) = V_B = 10 V. Continuing along gives V_B – 20 V = V_C = –10 V. And V_C + (2/3 A)(12 Ω) = V_D = –2 V

d. P = $\mathcal{E}$I = 40 W

1986B3

a. P = V^2R gives R = 240 Ω

b. Bulbs Y and Z in parallel have an equivalent resistance of 120 Ω. Adding bulb X in series with the pair gives R = 360 Ω

c. $P_T = \mathcal{E}^2/R_T$ = 40 W

d. I = $\mathcal{E}$/R = 1/3 A

e. $V_X = IR_X$ = 80 V

f. The current splits equally through Y and Z. $V_Z = I_ZR_Z$ = (1/6 A)(240 Ω) = 40 V

1987B4

a. The equivalent resistance of R_1 and R_2 is (12 × 4)/(12 + 4) = 3 Ω. Adding R_3 in series with the pair gives R = 12 Ω

b. $\mathcal{E} = IR_T$ = 4.8 V

c. The voltage across resistor 1 (equal to the voltage across R_2) is the emf of the battery minus the drop across R_3 which is 4.8 V – (0.4 A)(9 Ω) = 1.2 V

d. P = V^2/R = 0.36 W

e. Q = It = (0.4 C/s)(60 s) = 24 C

1988B3

a. On the right we have two resistors in series: $10\ \Omega + 2\ \Omega = 12\ \Omega$. This is in parallel with the $4\ \Omega$ resistor which is an equivalent resistance of $3\ \Omega$ and adding the remaining main branch resistor in series gives a total circuit resistance of $9\ \Omega$. The current is then $I = \mathcal{E}/R_T = 8$ A

b. The voltage remaining for the parallel branches on the right is the emf of the battery minus the potential dropped across the $6\ \Omega$ resistor which is $72\text{ V} - (8\text{ A})(6\ \Omega) = 24$ V. Thus the current in the $10\ \Omega$ resistor is the current through the whole $12\ \Omega$ branch which is $I = V/R = (24\text{ V})/(12\ \Omega) = 2$ A

c. $V_{10} = I_{10}R_{10} = 20$ V

d. When charged, the capacitor is in parallel with the $10\ \Omega$ resistor so $V_C = V_{10} = 20$ V and $Q = CV = 60\ \mu\text{C}$

e. $U_C = \frac{1}{2} CV^2 = 6 \times 10^{-4}$ J

1989B3

a. i. $P = I^2R = (2\text{ A})^2(10\ \Omega) = 40$ W
   ii. $P = Fv = mgv = 20$ W (using $g = 10\text{ m/s}^2$)
   iii. $P_B = P_R + P_M = 40\text{ W} + 20\text{ W} = 60$ W

b. i. $V = IR = 20$ V
   ii. $V = P/I = (20\text{ W})/(2\text{ A}) = 10$ V
   iii. $\mathcal{E} = V_R + V_M = 30$ V

c. Since the speed is increased by 3/2, the voltage drop increases by the same value and is now $(3/2)(10\text{ V}) = 15$ V

d. The new voltage across the resistor is found from $V_R = \mathcal{E} - V_M = 15$ V and $I = V_R/I = (15\text{ V})/(2\text{ A}) = 7.5\ \Omega$

1990B3

a. The $4\ \Omega$ and $8\ \Omega$ are in series so their equivalent resistance is $12\ \Omega$. Another $12\ \Omega$ resistor in parallel makes the equivalent resistance $(12 \times 12)/(12 + 12) = 6\ \Omega$

b. Adding the remaining resistors in series throughout the circuit gives a total circuit resistance of $12\ \Omega$ and the total current (which is also the current in the $5\ \Omega$ resistor) $= \mathcal{E}/R = 2$ A

c. $V_{AC} = \mathcal{E} - Ir = 22$ V

d. The current divides equally between the two branches on the right so $P_{12} = I^2R = (1\text{ A})^2(12\ \Omega) = 12$ W

e. From B to C you only have to pass through the $12\ \Omega$ resistor which gives $V = (1\text{ A})(12\ \Omega) = 12$ V

f. $P_B = V_{AC}^2/R_{external} = (22\text{ V})^2/11\ \Omega = 44$ W

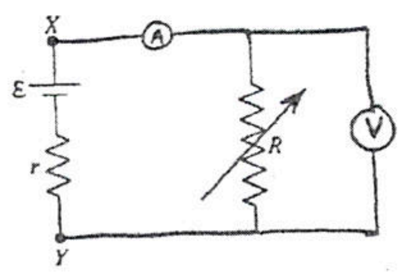
1991B4

a/b. $V_{XY} = \mathcal{E} - Ir$ and using data from the graph we can find two equations to solve simultaneously
$4\text{ V} = \mathcal{E} - (1\text{ A})r$ and $3\text{ V} = \mathcal{E} - (3\text{ A})r$ will yield the solutions $\mathcal{E} = 4.5$ V and $r = 0.5\ \Omega$

c. $V_{XY} = IR$ which gives $3\text{ V} = (3\text{ A})R$ and $R = 1\ \Omega$

d. I_{max} occurs for $R = 0$ and $V_{XY} = 0$ which gives $\mathcal{E} = I_{max}r$ and $I_{max} = 9$ A (this is the x intercept of the graph)

e.

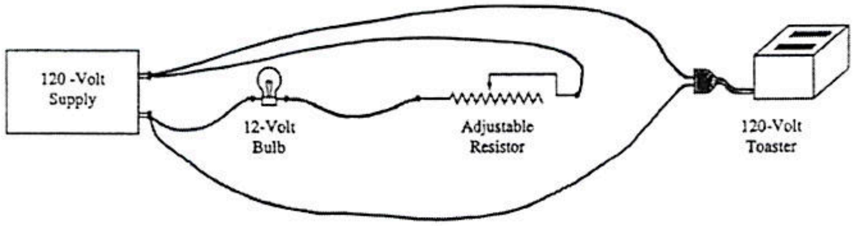


1995B2

a. $P = V^2/R$ gives $R = 24\ \Omega$

b. $E = Pt$ where $t = (30\text{ days})(24\text{ h/day})(3600\text{ sec/h})$ gives $E = 1.6 \times 10^7$ J

c.



The bulb, needing only 12 V must have a resistor in series with it and the toaster, requiring 120 V must be connected directly to the power supply.

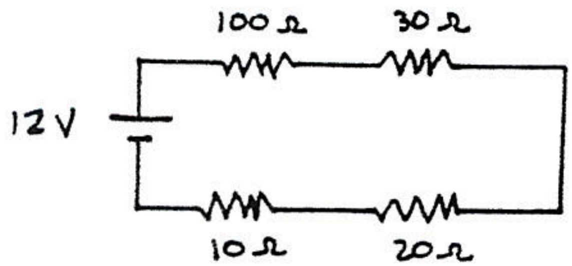
d. The current through the bulb is $I = P/V = 0.5$ A, which is also the current in the resistor, which must have 108 V across it to provide the light bulb only 12 V. $R = V/I = (108\text{ V})/(0.5\text{ A}) = 216\ \Omega$

e. i. If the resistance of the resistor is increased, the current through the branch will decrease, decreasing the brightness of the bulb.

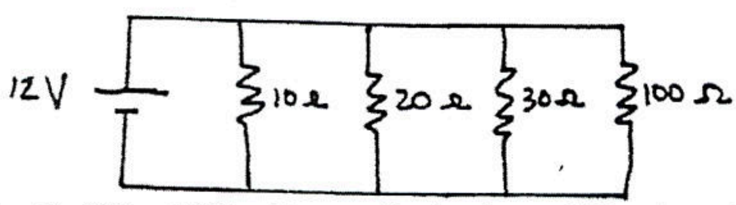
ii. Since the toaster operates in its own parallel branch, nothing will change for the toaster.

1996B4

a. For the smallest current, place the resistors in series



b. For the largest current, place the resistors in parallel



c. i. The 20 Ω and 30 Ω resistors combine in series as a 50 Ω resistor, which is in parallel with the 100 Ω resistor making their effective resistance 33.3 Ω. Adding the 10 Ω resistor in the main branch in series gives a total circuit resistance of 43 Ω. The current in the 10 Ω resistor is the total current delivered by the battery $\mathcal{E}/R = 0.28$ A

ii. $P = \mathcal{E}^2/R = 3.35$ W

d. $E = Pt$, or $t = E/P = (10 \times 10^3\text{ J})/(3.35\text{ W}) = 3 \times 10^3$ seconds

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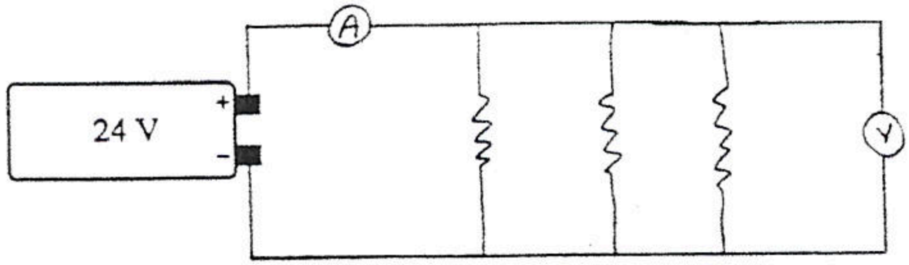
1997B4

a. i. In series $R_T = 90\ \Omega$ and $P = V^2/R = 6.4$ W

ii. In parallel $R_T = 10\ \Omega$ and $P = 57.6$ W

b. The fastest heating occurs with a parallel connection



2002B3B

a. The resistance of the 6 Ω and 3 Ω resistors in parallel is $(6 \times 3)/(6 + 3) = 2\ \Omega$. Adding the 3 Ω resistor in the main branch gives a total circuit resistance of 5 Ω. The current in bulb A in the main branch is the total current delivered by the battery $I = \mathcal{E}/R = (9\ \text{V})/(5\ \Omega) = 1.8$ A

b. Bulb A is the brightest. In the main branch, it receives the most current. You can also calculate the power of each resistor where $P_A = 9.7$ W, $P_B = 2.2$ W and $P_C = 4.3$ W

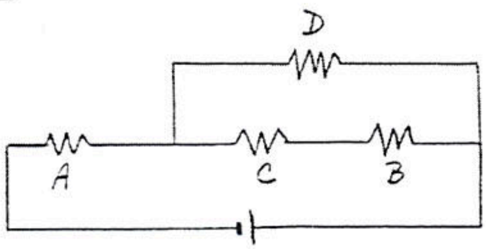
c. i. Removing Bulb C from the circuit changes the circuit to a series circuit, increasing the total resistance and decreasing the total current. With the total current decreased, bulb A is dimmer.

ii. Since bulb A receives less current, the potential drop is less than the original value and being in a loop with bulb B causes the voltage of bulb B to increase, making bulb B brighter. The current through bulb B is greater since it is no longer sharing current with bulb C.

iii. The current through bulb C is zero, bulb C goes out.

1998B4

a.



b. A > D > B = C

Bulb *A* has the largest current through it, making it brightest. The voltage across bulb *D* is the same as that across bulbs Band C combined, so it is next brightest, leaving *B* and C as least bright Bulbs *B* and C are in series, and thus have the same current through them, so they must be equally bright.

c. i. The brightness of bulb A decreases. The total resistance of the circuit increases so the current in bulb A decreases.

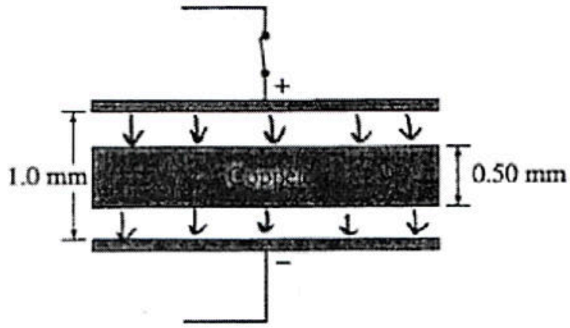
ii. The brightness of bulb B increases. The current (and the voltage) across B increases. Even though the total current decreases, it is no longer splitting to do through the branch with bulb D. Another way to look at it is since A has less current, the potential difference across A is decreased, this allows a larger share of the battery voltage to be across B and C.

2000B3

a. The equivalent resistance of the two resistors in parallel is R/2, which if ½ the resistance of the resistor in the main branch, so the parallel combination will receive half the potential difference of the main branch resistor. The 30 V of the battery will then divide into 20 V for the main branch resistor (and across the voltmeter) and 10 V each for the resistors in parallel.

b. After the switch has been closed for a long time, the voltage across the capacitor will be 30 V.
$Q = CV = 3 \times 10^8$ C

c. i. The 30 V battery is still connected across the capacitor so the potential difference remains 30 V.
ii. $E = 0$ inside a conductor in electrostatic equilibrium
iii.



iv. $E = V/d$ and you can use the entire gap or just one of the two gaps; $E = 30$ V/(0.5 mm) or 15 V/(0.25 mm)
$E = 60$ V/mm or 60,000 V/m

2002B3

a. i. $P = V^2/R$ gives $R = 480\ \Omega$ and $V = IR$ gives $I = 0.25$ A
ii. $P = V^2/R$ gives $R = 360\ \Omega$ and $V = IR$ gives $I = 0.33$ A

b. i./ii. The resistances are unchanged = 480 Ω and 360 Ω. The total resistance in series is 480 Ω + 360 Ω = 840 Ω making the total current $I = V/R = 0.14$ A which is the same value for both resistors in series

c. The bulbs are brightest in parallel, where they provide their labeled values of 40 W and 30 W. In series, it is the larger resistor (the 30 W bulb) that glows brighter with a larger potential difference across it in series.
This gives the order from top to bottom as **2 1 3 4**

d. i. In parallel, they each operate at their rated voltage so they each provide their rated power and $P_T = 30\text{ W} + 40\text{ W} = 70$ W
ii. In series $P_T = V_T^2/R_T = 17$ W

2003B2

a. For two capacitors in series the equivalent capacitance is $(6 \times 12)/(6 + 12) = 4\ \mu$F

b. The capacitors are fully charged so current flows through the resistors but not the capacitors. $R_T = 30\ \Omega$ and $I = V/R = 0.2$ A

c. The potential difference between A and B is the voltage across the 20 Ω resistor. $V = IR = 4$ V

d. The capacitors in series store the same charge as a single 4 μF capacitor. $Q = CV = (4\ \mu\text{F})(4\text{ V}) = 16\ \mu$C

e. Remains the same. No current is flowing from A to P to B therefore braking the circuit at point P does not affect the current in the outer loop, and therefore will not affect the potential difference between A and B.

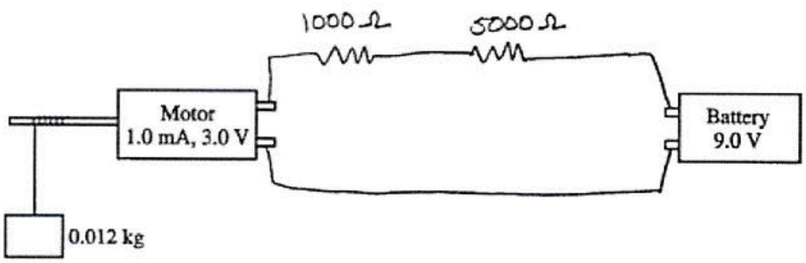
2003B2B

a. $P = IV = 3\ mW = 3 \times 10^{-3}\ W$

b. $E = Pt = 0.180\ J$

c. e = "what you get"/"what you are paying for" = (power lifting the mass) ÷ (power provided by the motor)
$P_{lifting} = Fv = mgv = mgd/t = 1.96\ mW$ so the efficiency is $1.96/3 = 0.653$ or 65.3 %

d. To reduce the battery voltage of 9 V to the motor's required voltage of 3 V, we need 6 V across the resistors. The required resistance is then $V/I = (6\ V)/(1\ mA) = 6000\ \Omega$. This is done with a 1000 Ω and a 5000 Ω resistor in series.



2007B3

a. i. <u>1</u> I_A <u>3</u> I_B <u>2</u> I_C

ii. The total current flows through R_A and gets divided between the other two resistors with the smaller resistor R_C getting a larger current

b. i. <u>1</u> V_A <u>2</u> V_B <u>2</u> V_C

ii. No resistor is greater than R_A and R_A has the full current through it. R_B and R_C are in parallel and therefore have the same potential difference.

c. For the two resistors in parallel, the equivalent resistance is $(2R \times R)/(2R + R) = 2/3\ R = 133\ \Omega$. Adding R_A in series with the pair gives $R_T = 400\ \Omega + 133\ \Omega = 533\ \Omega$

d. $I_T = I_A = \mathcal{E}/R_T = 0.0225\ A$. The potential drop across A is $V = IR = 9\ V$ which leaves 3 V for the two branches in parallel. $I_C = V_C/R_C = 0.015\ A$

e. In the new circuit, $I_B = 0$ at equilibrium and the circuit behaves as a simple series circuit with a total resistance of 600 Ω and a total current of $\mathcal{E}/R = 0.02\ A$. The voltage across the capacitor is the same as the voltage across resistor C and $V_C = IR_C = 4\ V$ and $Q = CV = 8 \times 10^{-6}\ C$

1975E2

a. $Q = C\mathcal{E} = 12\ \mu F \times 100\ V = 1200\ \mu C$

b. Connecting the two capacitors puts them in parallel with the same voltage so $V_1 = V_2$ and $V = Q/C$ which gives $Q_1/C_1 = Q_2/C_2$ or $Q_1/12 = Q_2/24$ and $Q_2 = 2Q_1$. We also know the total charge is conserved so $Q_1 + Q_2 = 1200\ \mu C$ so we have $Q_1 + 2Q_1 = 1200\ \mu C$ so $Q_1 = 400\ \mu C$

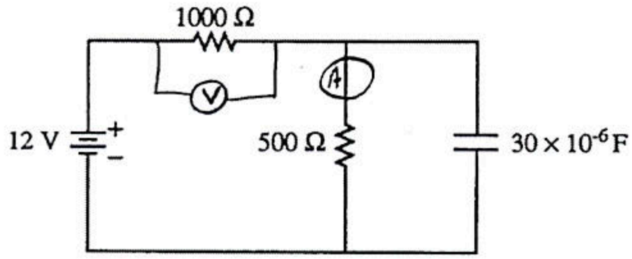
c. $V = Q/C = 33.3\ V$

d. When the battery is reconnected, both capacitors charge to a potential difference of 100 V each. The total charge is then $Q = Q_1 + Q_2 = (C_1 + C_2)V = 3600\ \mu C$ making the *additional* charge from the battery 2400 μC.

2007B3B

a. In their steady states, no current flows through the capacitor so the total resistance is 1500 Ω and the total current is $\mathcal{E}/R_T = 8.0 \times 10^{-3}$ A

b.



c. The voltage across the capacitor is the same as the voltage across the 500 Ω resistor = IR = 4 V so we have Q = CV = 1.2×10^{-4} C

d. $P = I^2R = 6.4 \times 10^{-2}$ W

e. Larger. Replacing the 50 Ω resistor with a larger resistor lowers the steady state current, causing the voltage across the 1000 Ω resistor to decrease and the voltage across the replacement resistor to increase.

1988E2

a. In their steady states, no current flows through the capacitor so the effective resistance of the branch on the right is 8 Ω + 4 Ω = 12 Ω. This is in parallel with the 4 Ω resistor making their effective resistance (12 × 4)/(12 + 4) = 3 Ω. Adding the 9 Ω resistor in the main branch gives a total circuit resistance of 12 Ω and a total current of $\mathcal{E}/R$ = 10 A. This is the current in the 9 Ω resistor as it is in the main branch.

b. With 10 A across the 9 Ω resistor, the potential drop across it is 90 V, leaving 30 V across the two parallel branches on the right. With 30 V across the 12 Ω effective resistance in the right branch, we have a current through that branch (including the 8 Ω resistor) of V/R = 2.5 A

c. $V_C = V_4 = IR$ = (2.5 A)(4 Ω) = 10 V

d. $U_C = ½\ CV^2$ = 1500 μJ

1985E2

a. Immediately after the switch is closed, the capacitor begins charging with current flowing to the capacitor as if it was just a wire. This short circuits R_2 making the total effective resistance of the circuit 5×10^6 Ω and the total current $\mathcal{E}/R_{eff}$ = 0.006 A

b. When the capacitor is fully charged, no current flows through that branch and the circuit behaves as a simple series circuit with a total resistance of 15×10^6 Ω and a total current of $\mathcal{E}/R$ = 0.002 A

c. The voltage across the capacitor is equal to the voltage across the 10 MΩ resistor as they are in parallel. $V_C = V_{10M}$ = IR = 2000 V and Q = CV = 0.01 C

d. $U_C = ½\ CV^2$ = 10 J

1986E2

a. The resistance of the two parallel branches are equal at 40 Ω each making the equivalent resistance of the two branches 20 Ω. Adding the 5 Ω resistance in the main branch gives a total circuit resistance of 25 Ω and a total current of $\mathcal{E}/R$ = 1 A which will split evenly between the two equal branches giving I_R = 0.5 A

b. After the capacitor is charged, no current flows from A to B, making the circuit operate as it did initially when the capacitor was not present. Therefore the current through R is the same as calculated above at 0.5 A

c. Consider the voltage at the junction above resistor R. The potential drop from this point to point A is V = IR = (0.5 A)(10 Ω) = 5 V and to point B is (0.5 A)(30 Ω) = 15 V making the potential difference across the plates of the capacitor 15 V – 5 V = 10 V. Q = CV = (10 μF)(10 V) = 100 μC

1989E3

a. When charged, the potential difference across the capacitor is 20 V. $U_C = \frac{1}{2} CV^2 = 1200$ μJ

b. Given that the charge is initially unchanged, the work done is the change in the energy stored in the capacitor. Increasing the distance between plates to 4 times the initial value causes the capacitance to decrease to ¼ its initial value ($C \propto 1/d$). Since $Q_i = Q_f$ we have $C_iV_i = C_fV_f$ so $V_f = 4V_i$
$W = \Delta U_C = \frac{1}{2} C_fV_f^2 - \frac{1}{2} C_iV_i^2 = \frac{1}{2}(\frac{1}{4} C(4V)^2) - \frac{1}{2} CV^2 = 3600$ μJ

c. After the spacing is increased, the capacitor acts as a battery with a voltage of 4V = 80 V with its emf opposite that of the 20 V battery making the effective voltage supplied to the circuit 80 V – 20 V = 60 V.
$I = \mathcal{E}_{eff}/R = 2 \times 10^{-4}$ A

d. The charge on the capacitor initially was $Q = CV = 120$ μC and after the plates have been separated and a new equilibrium is reach $Q = (\frac{1}{4}C)V = 30$ μC so the charge that flowed back through the battery is 120 μC – 30 μC = 90 μC

e. For the battery $U = Q_{added}V = 1800$ μJ

1992E2

a. i. $Q = CV = 4 \times 10^{-3}$ C
ii. $U_C = \frac{1}{2} CV^2 = 4$ J

b. When the switch is closed, there is no charge on the 6 μF capacitor so the potential difference across the resistor equals that across the 2 μF capacitor, or 2000 V and $I = V/R = 2 \times 10^{-3}$ A

c. In equilibrium, charge is no longer moving so there is no potential difference across the resistor therefore the capacitors have the same potential difference. $V_2 = V_6$ gives $Q_2/C_2 = Q_6/C_6$ giving $Q_6 = 3Q_2$ and since total charge is conserved we have $Q_2 + Q_6 = Q_2 + 3Q_2 = 4Q_2 = 4 \times 10^{-3}$ C so $Q_2 = 1 \times 10^{-3}$ C and $Q_6 = 3 \times 10^{-3}$ C

d. $U_C = U_2 + U_6 = Q_2^2/2C_2 + Q_6^2/2C_6 = 1$ J. This is less than in part a. ii. Part of the energy was converted to heat in the resistor.

1995E2

a. $C = \kappa\varepsilon_0A/d$ so $\kappa = Cd/\varepsilon_0A = 5.65$

b. i. When the switch is closed, the voltage across the capacitor is zero thus all the voltage appears across the resistor and $I = \mathcal{E}/R = 1.5 \times 10^{-5}$ A

c. When fully charged, the current has stopped flowing and all the voltage now appears across the capacitor and $Q = CV = 1.5 \times 10^{-6}$ C and since the bottom plate is connected to the negative terminal of the battery the charge on that plate is also negative.

d. $U_C = \frac{1}{2} CV^2 = 2.25 \times 10^{-5}$ J

e. Since the capacitor is isolated, the charge on it remains the same. Removing the plastic reduces the capacitance to $C' = \varepsilon_0A/d = C_{original}/\kappa$ and $V = Q/C' = 170$ V

f. $U' = Q^2/2C' = Q^2/2(C/\kappa) = \kappa(Q^2/2C) = \kappa U > U_{original}$. The increase came from the work that had to be done to remove the plastic from the capacitor.

1996E2

a. The initial charge on C_1 is $Q = CV_0 = 200$μC. In equilibrium, charge is no longer moving so there is no potential difference across the resistor therefore the capacitors have the same potential difference. $V_1 = V_2$ gives $Q_1/C_1 = Q_2/C_2$ giving $Q_2 = 3Q_1$ and since total charge is conserved we have $Q_1 + Q_2 = Q_1 + 3Q_1 = 4Q_1 = 200$ μC so $Q_1 = 50$ μC and $Q_2 = 150$ μC

b. $\Delta U = U_f - U_i = (Q_1^2/2C_1 + Q_2^2/2C_2) - \frac{1}{2} C_1V_0^2 = -3750$ μJ

2008E2

a. With a 50 Ω resistor, the right branch has a total resistance of 150 Ω, making the parallel combination with the 300 Ω resistor equal to (150 × 300)/(150 + 300) = 100 Ω. Adding R_1 from the main branch in series with the branches gives a total circuit resistance of 300 Ω and a total current of $\mathcal{E}/R$ = 5 A. The potential difference across R_1 is then V = IR = 1000V, leaving 500 V across the two parallel branches and across R_2.

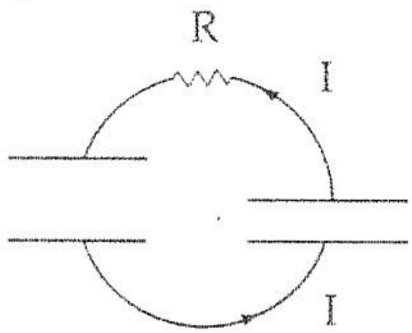
b. When the switch is closed with a capacitor between points A and B, the voltage across the capacitor is zero and the current flows through the branch as if the capacitor was a wire. This gives the effective resistance of the parallel resistors as (100 × 300)/(100 + 300) = 75 Ω and the total resistance = 275 Ω, the total current = $\mathcal{E}/R$ = 5.45 A, the voltage across R_1 = IR = 1090 V and V_2 = 1500 V – 1090 V = 410 V

1978B3

a. V = Ed = Es

b. Since the field points from the power plate to the upper plate, the lower plate is positive and the upper plate is negative.

c.



When the potential difference is the same on the two capacitors, charge will stop flowing as charge will flow only when there is a difference in potential.

d. The capacitor on the left has the smaller capacitance and since the two capacitors are in parallel, they have the same voltage. Q = CV so the larger capacitor (on the right) contains more charge.

e. The energy lost has been converted to heat through the resistor.