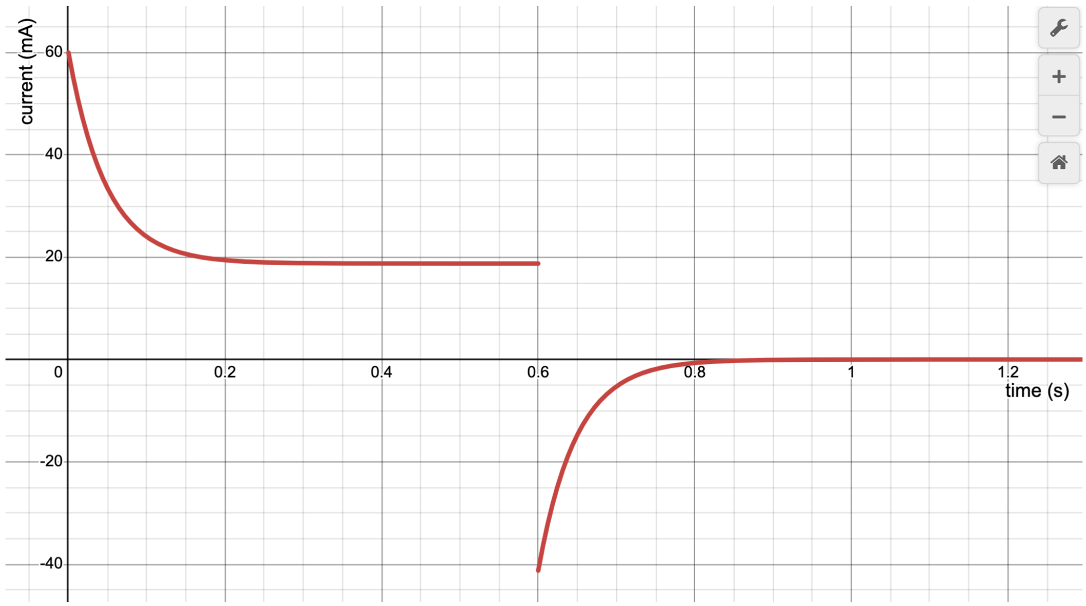
AP Physics C Capacitance Homework - Answers

1. a. 14 mC
   b.2.5 mA
   c. 21 mJ
2. a. 100 μF
   b. 27 A
   c. 0.066 C, 21 J
3. a. 2160 F
   b. A capacitor is like a battery in the sense that it can "provide a voltage" and store energy, but the voltage drops steadily as the energy and charge stored in the capacitor decreases. A battery on the other hand has a fairly constant voltage as its chemical energy is depleted.
4. a. 2.0 V, 0.50 A
   b. 0.0 mC 0.0 V 1.5 A
   0.1 mC 1.0 V 1.0 A
   0.2 mC 2.0 V 0.5 A
   0.3 mC 3.0 V 0.0 A
   c. It takes greater and greater time for the charge stored to increase by equal amounts of 0.10 mC. As shown by the calculations in part (b), the current decreases as the charge and voltage of the capacitor increase. With less current it takes more time for each ensuing charge of 0.10 mC to be delivered to the plates of the capacitor.
5. a. $I = \frac{Q}{RC}$
   b. $t_{1/2} \approx \frac{2}{3}RC$
   c. $Q/64$
6. a. $Q_1 = Q_2 = 0.24$ mC,
   $V_1 = 8.00$ V,
   $V_2 = 4.00$ V
   b. $Q_1 = 0.36$ mC
   $Q_2 = 0.72$ mC,
   $V_1 = V_2 = 12.0$ V
   c. 20.0 μF, 90.0 μF
7. a. $Q_1 = 48.0$ μC
   $Q_2 = 72.0$ μC,
   $V_1 = V_2 = 2.40$ V
   b. 72.0 μC
8. a. $I_1 = 0.60$ A
   $I_2 = 0.12$ A
   $I_3 = 0.48$ A
   b. 2.5 V
   c. 5.0 μC
   d. 5.0 μJ
9. a. 2.22 nF
   b. 12.2 nC
   c. 2.50 mJ

10. a. 1.11×10^{-7} m
 b. 13.4 m
11. a. 0.62 nC
 b. 2.5 nJ
12. a. Use the relation $F = -\frac{dU}{dx}$ as applied to the energy of a capacitor $U = \frac{Q^2}{2C}$, where $C = \frac{\epsilon_0 A}{x}$.
 OR use $\vec{E} = \frac{\vec{F}}{q}$ and $E = \frac{\sigma}{\epsilon_0}$
 b. As the two plates get closer and closer together there are two offsetting factors for individual point charges within each plate. Consider a single electron near the center of the negative plate. As the positive plate gets closer, this particular electron is getting closer to a corresponding proton near the center of the positive plate, and therefore is more attracted to that particular proton. However protons that are near the edges of the positive plate are now pulling on the electron in nearly opposite directions. The net force coming from the edges of the positive plate *decreases* as the plates get closer because the force components perpendicular to the plates is getting less. Similar arguments can be made for every electron in the negative plate.
13. a. 18 nF
 b. 1600 V, 23 mJ
14. a. before:
 3.1 nC, 12 V,
 1$\underline{0}$ kV/m, 19 nJ;
 after:
 3.1 nC, 5.7 V,
 4.8 kV/m, 8.9 nJ
 b. –9.7 nJ
15. a. before is same;
 after:
 6.5 nC, 12.0 V,
 1$\underline{0}$ kV/m, 39 nJ
 b. –2$\underline{0}$ nJ
16. $C = \frac{2\epsilon_0 A\kappa}{d(\kappa+1)}$
17. a. 284 pF
 b. 7.05 nJ
18. a. $C = \frac{2\pi\epsilon_0 L}{\ln\left(\frac{R_2}{R_1}\right)}$
 b. 16
19. a. $C = 4\pi\varepsilon_0 R$
 b. 13.9 pF
 c. 216 kV, 0.324 J
20. a. 27 mA
 b. 2.0 mC
 c. $t = 0.027$ s
 d. 12 mJ
21. a. 0.69 s
 b. 0.27 mA

22. a. 1.74 s
    b. 2.09 mF
23. a. 6$\underline{0}$ mA
    b. 19 mA
    c. 2.9 mC
    d. 34 ms
    e.



24. a. 0.72 A
    b. 0.23 mC
    c. 0.13 A
    d.