

Ch 25 HW Assignment: Answers & HW Hints (Pt. 1)

Part 1: Intro to Capacitance

Pg. 676-677 #1, 2, 4-6

Answers

1a. 3.5 pF

b. 3.5 pF

c. 57.1 V

2. 3 mC

4a. 8.85×10^{-12} m

b. No. (Smaller than an atomic radius.)

5a. 1.44×10^{-10} F

b. 1.728×10^{-8} C

6a. 8.45×10^{-11} F

b. 191 cm²

Ch 25 #1

Part A is easy.

For part B, since you're not changing anything about the geometric arrangement of the 'plates', you wouldn't expect the capacitance to change at all.

For part C, you would definitely expect a different potential difference if the charge is different now.

Ch 25 HW Assignment: Answers & HW Hints (Pt. 2)

Part 2: Capacitors in Series & Parallel

Pg. 677-678 #10, 11, 14a, 15, 20, 21, 37a

Answers

10. 9091 capacitors

11. 0.315 C

14a. $60 \mu\text{C}$

15. 43 pF

20. $20 \mu\text{C}$

21. 3.59 pC

37a. 190.1 V

Ch 25 #14a

You can figure out the initial charge stored in the parallel group using ideas from class. Then think about what happens because of the squeeze. The squished capacitor has only half its initial separation distance 'd' between plates, leading to twice as great a capacitance. This means that the equivalent capacitance of the group has increased, so the total charge stored has also increased. To finish, don't forget that you weren't asked for final charge stored, but for the excess charge that flows when the squeeze occurs.

Ch 25 #15

This is just a backwards version of the one in class. Figure out initial charge stored, then realize that this total charge can't change in the new arrangement. So since you know the new voltage, figure out the new equivalent resistance. Then some nice easy subtraction, and you should be home free.

Ch 25 #20

When the switch is thrown to the left, only C_1 is connected across the battery's potential difference. So calculate the charge it stores initially. Then when the switch is thrown to the right, that total amount of charge doesn't change, but rearranges itself on the plates of all three capacitors until they each come to equal potential differences. Find this final V value, then apply that V value to find the Q stored on just the C_1 when it's at that potential.

Ch 25 #21

The weird thing on this one is the way you were told info about the two capacitors. You don't know their C values, but you also can't find them because you don't know the separation distances between their plates. And you were also told E, but what for? How about this...

$$Q = (C)(V) = (\epsilon_0 A/d)(Ed) = \epsilon_0 AE$$

Apply that equation to each capacitor.

Ch 25 #37a

Before starting, give it some thought... The capacitors will all store equal amounts of charge, but they will each be at different voltages, given by $V=Q/C$. So the max V will occur for the smallest C , so you've got to start by focusing on the $10\mu\text{F}$ capacitor. Find the amount of charge it will store at max voltage of 100V . This amount of charge is also the total charge that the series will store at max voltage, so use $V_{\text{total}} = Q_{\text{total}} / C_{\text{total}}$ to find the total max V that can be applied to the series. (You do have to find C_{total} first, of course.)

Ch 25 HW Assignment: Answers & HW Hints (Pt. 3)

Part 3: More Series & Parallel

Pg. 677-678 #8, 9, 12, 17ab, 25

Answers

8. $7.33 \mu\text{F}$

9. $3.16 \mu\text{F}$

12a. $100 \mu\text{C}$

b. $20 \mu\text{C}$

17a. $3 \mu\text{F}$

b. $60 \mu\text{C}$

25a. 4.5×10^{14} electrons

b. 1.5×10^{14} electrons

c. 3.0×10^{14} electrons

d. 4.5×10^{14} electrons

e. Up

f. Up

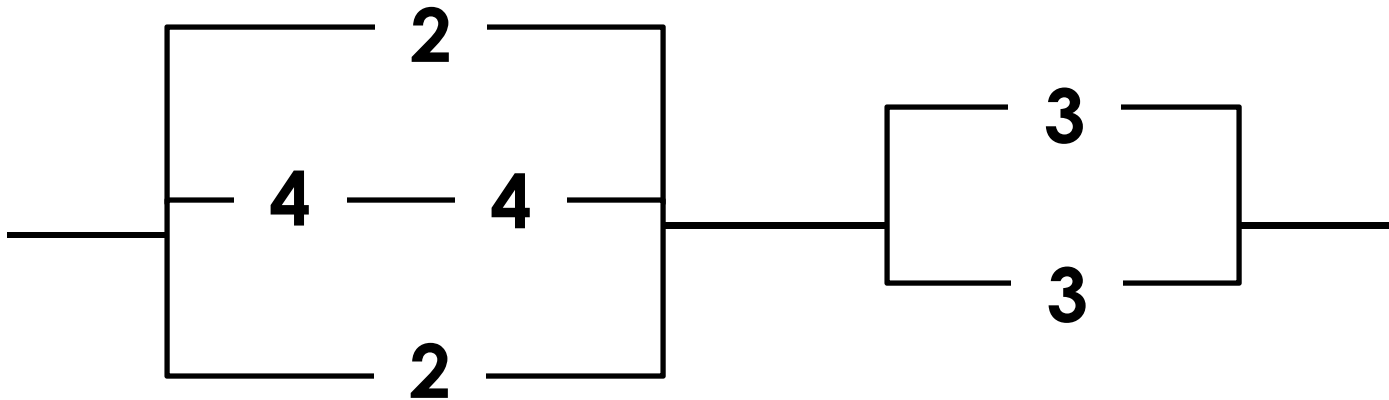
Ch 25 #12

Hopefully you can see for part A that you can basically just treat that capacitor as if it were in its own separate circuit, and that should make part A pretty doggone simple.

For part B, you need to simplify the circuit using the step-by-step method discussed in class.

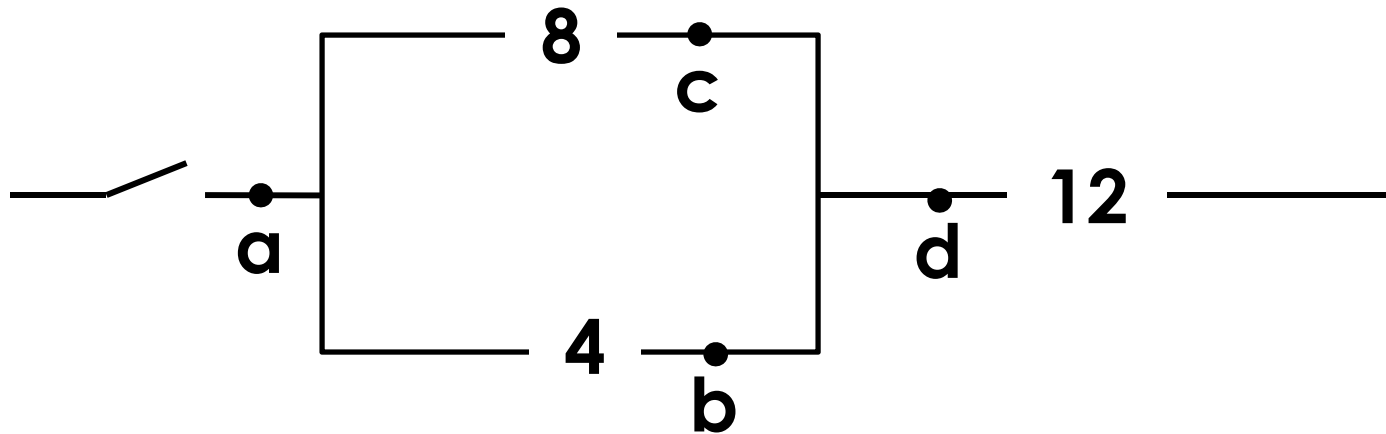
Ch 25 #17

Your simplified diagram should look like the one below. Make sure you understand why the two diagrams match.



Ch 25 #25

Your simplified diagram should look like the one below. Make sure you understand why the two diagrams match.



Ch 25 HW Assignment: Answers & HW Hints (Pt. 4)

Part 4: Energy Stored in Capacitors

Pg. 679 #29, 30, 35, 39

Answers

29. 0.27 J

30a. 3.54×10^{-11} F

b. 2.12×10^{-8} C

c. 6.36 μ J

d. 600,000 V/m

e. 1.59 J/m^3

35a. 16V

b. 4.51×10^{-11} J

c. 1.2×10^{-10} J

d. 7.5×10^{-11} J

39. 0.113 J/m^3

Ch 25 #35

For part A, make sure you realize that you're being asked to find V *after* the plates have been separated farther from each other. Think about it in terms of $V=Q/C$, and how Q won't change when you move the plates farther apart, but C will change.

When you eventually get to part D, try to see how you can use your answers from part B and C to find the answer to part D.

Ch 25 #39

The idea on this one is that you can talk in terms of energy being stored in any electric field, not just E-fields in capacitors. So to get this energy density, you just need to know how strong the E-field is at that point in space. Go back to some E-field and potential ideas to figure out the strength of the E-field, and then you should be good to calculate the energy density.

Ch 25 HW Assignment: Answers & HW Hints (Pt. 5)

Part 5: Intro to Dielectrics

Pg. 679-680 #40-42, 44, 45, 47, 49, 48

Answers

40a. 0.062m

b. 280 pF

41. Pyrex ($k=4.7$)

42. $k=4$

44. 1.06 nC

45. 0.63 m²

47. 6.6×10^{-5} J

49. 17.32 pF

48. 8.4 pF

Ch 25 #42

This one's almost more of a conceptual question, rather than a quantitative problem. So make sure you understand why the answer's $k=4$, but don't feel bad if you don't have much work to show.

Ch 25 #45

Start by meeting the criteria to “withstand a potential difference of 4.0kV” and then move on to calculating area once you know ‘d’.

Ch 25 #47

They told you two different sets of info that allow you to calculate two different quantities. First they told you plenty to find its capacitance value. Then they also told you enough to know the maximum voltage it can withstand. So find those two things, and then use 'em to calculate max energy it can store.

Ch 25 #48-49

These two might seem weird at first, but with some thought, they'll turn out to be pretty simple, actually. #49 is a little easier to visualize, so let's start there. Notice that the two different dielectrics are going to produce two different values for capacitance across the regions they fill. So why couldn't you just view these as two capacitors in series, each with $d=4.62\text{mm}/2$, as shown?



Continued on next page

Ch 25 #48-49 (cont.)

So #49 actually turns into a pretty straightforward problem with two different capacitors (you have to find their “C” values) in series.

For #48, it might be a little harder to see, but you can treat it as if there are just two different capacitors, each with plate area of $A/2$, that are in parallel with each other.

Ch 25 HW Assignment: Answers & HW Hints (Pt. 6)

Part 6: Intro to Dielectrics

Pg. 680 #51, 54, 55

Answers

51a. 10,458 V/m

b. 5.0 nC

c. 4.07 nC

54a. 7.2

b. 7.7×10^{-7} C

55a. 88.5 pF

b. 120.3 pF

c. 10.6 nC

d. 10.6 nC

e. 9977 V/m

f. 2078 V/m

g. 88.1 V

h. -1.69×10^{-7} J

Ch 25 #54

Part A might feel like you weren't given enough info to use the k formula you know. But here's a quick derivation that might help...

$$E = \frac{V}{d} = \frac{Q/C}{d} = \frac{\frac{Q}{k\epsilon_0 A/d}}{d} = \frac{Q}{k\epsilon_0 A}$$

Ch 25 #55

In general, you should note that this one's different because the capacitor's disconnected from the battery, and because the dielectric doesn't fill the whole space between the plates. The easiest way to think about the dielectric, then, is probably to view the one capacitor as really acting like a series combination of capacitors, one of which has air between the plates, and the other having the dielectric filling it. (Similar to #49.) This thinking should help on most parts, but for part H...

Continued on next page

Ch 25 #55 (cont.)

... you need to remember how we handled this question earlier this chapter. To find work required to insert the dielectric, you really just need to find the difference between energy stored by the capacitor before and after its insertion. When you find the two values for energy stored, you'll actually notice that there was more energy stored before the dielectric is inserted, which must mean that it didn't really take any external work at all to insert the dielectric, and it was instead 'pulled' into the capacitor.