Chapter 24
Young and Friedman, 13 th ed.

 24.1. Identify**:**   The capacitance depends on the geometry (area and plate separation) of the plates.

Set Up**:**   For a parallel-plate capacitor,   and 

Execute:   (a) 

(b) Solving for the area gives 

(c) 

Evaluate:   The capacitance is reasonable for laboratory capacitors, but the area is rather large.

 24.4. Identify:    when there is air between the plates.

Set Up:    is the area of each plate.

Execute:   

Evaluate:   *C* increases when *A* increases and *C* increases when *d* decreases.

 24.6. Identify:   

Set Up:   When the capacitor is connected to the battery, enough charge flows onto the plates to make 

Execute:   (a) 12.0 V

(b) (i) When *d* is doubled, *C* is halved.  and *Q* is constant, so *V* doubles. 

(ii) When *r* is doubled, *A* increases by a factor of 4. *V* decreases by a factor of 4 and 

Evaluate:   The electric field between the plates is   When *d* is doubled *E* is unchanged and *V* doubles. When *A* is increased by a factor of 4, *E* decreases by a factor of 4 so *V* decreases by a factor of 4.

 24.9. Identify:   The energy stored in a capacitor depends on its capacitance, which in turn depends on its geometry.

Set Up**:**    for any capacitor, and  for a parallel-plate capacitor.

Execute**:**   (a)  Using  gives 

(b) ****   so 

Evaluate:   Doubling the plate separation halves the capacitance, so twice the potential difference is required to keep the same charge on the plates.

Evaluate:   It requires many small cells to produce a large voltage surge.

24.16. Identify:   The capacitors between *b* and *c* are in parallel. This combination is in series with the 15 pF capacitor.

Set Up:   Let   and 

Execute:   (a) For capacitors in parallel,  so 

(b)  is in series with  For capacitors in series,  so  and 

Evaluate:   For capacitors in parallel the equivalent capacitance is larger than any of the individual capacitors. For capacitors in series the equivalent capacitance is smaller than any of the individual capacitors.

 24.20**.** Identify:   For capacitors in parallel the voltages are the same and the charges add. For capacitors in series, the charges are the same and the voltages add. 

Set Up:    and  are in parallel and  is in series with the parallel combination of  and 

Execute:   (a)  are in parallel and so have the same potential across them:  Therefore,  Since  is in series with the parallel combination of  its charge must be equal to their combined charge: 

(b) The total capacitance is found from  and  

Evaluate:    

 24.25. Identify and Set Up:   The energy density is given by Eq. (24.11):  to solve
for *E*.

Execute:   Calculate 

Then 

Evaluate:   *E* is smaller than the value in Example 24.8 by about a factor of 6 so *u* is smaller by about a factor of 

 24.30. Identify**:**   The two capacitors are in series.   

Set Up:   For capacitors in series the voltages add and the charges are the same.

Execute:   (a)  so 



(b)  for each capacitor.

(c) 

(d) We know *C* and *Q* for each capacitor so rewrite *U* in terms of these quantities. 

150 nF:  120 nF: 

Note that  the total stored energy calculated in part (c).

(e) 150 nF:  120 nF: 

Note that these two voltages sum to 36 V, the voltage applied across the network.

Evaluate:   Since *Q* is the same, the capacitor with smaller *C* stores more energy  and has a larger voltage 

 24.31. Identify**:**   The two capacitors are in parallel.   

Set Up:   For capacitors in parallel, the voltages are the same and the charges add.

Execute:   (a)  

(b)  for each capacitor.

35 nF:  75 nF:  Note that 

(c) 

(d) 35 nF: 

75 nF:  Since *V* is the same the capacitor with larger *C* stores more energy.

(e) 220 V for each capacitor.

Evaluate:   The capacitor with the larger *C* has the larger *Q*.

 24.66. Identify:   This situation is analogous to having two capacitors  in series, each with separation 

Set Up:   For capacitors in series, 

Execute:   **(a)** 

(b) 

(c) As   The metal slab has no effect if it is very thin. And as     is the potential difference between two points separated by a distance *y* parallel to a uniform electric field. When the distance is very small, it takes a very large field and hence a large *Q* on the plates for a given potential difference.