E. Arrambide Physics AP/Dual

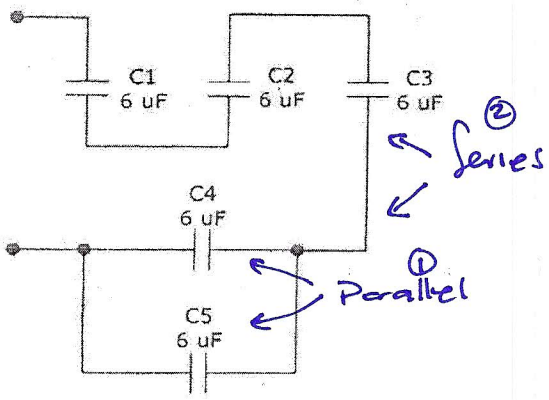
Name: _____ Period: _____ Date: _____

Electricity: Capacitors Problems 2

SERIES	PARALLEL	
$\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} + \cdots$	$C_T = C_1 + C_2 + \cdots$	
$C = \frac{Q}{V}$	$C = \varepsilon_o \frac{A}{d}$	$U = \frac{1}{2} Q \Delta V = \frac{1}{2} CV^2$

I. Simplify the following electric circuits and answer the following.

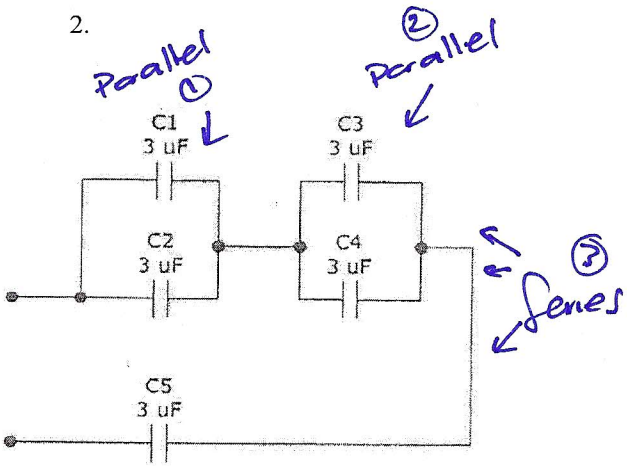
1.



Type of circuit: Combined

Total Capacitance: 12/7MF = 1.7MF

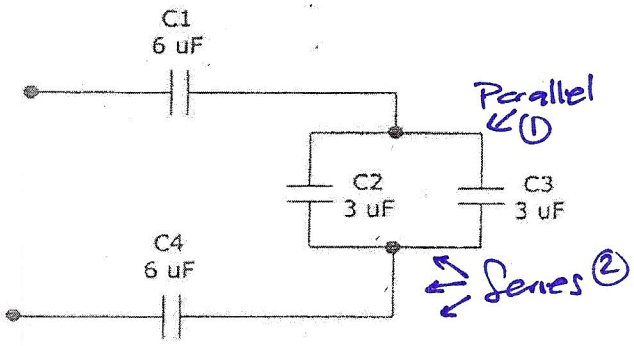
2.



Type of circuit: Combined

Total Capacitance: 3/2MF = 1.5MF

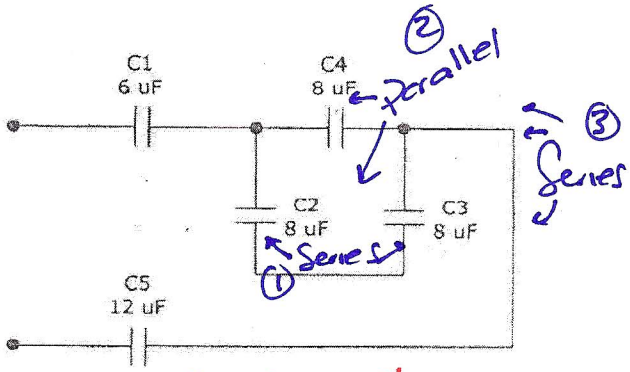
3.



Type of circuit: Combined

Total Capacitance: 2MF

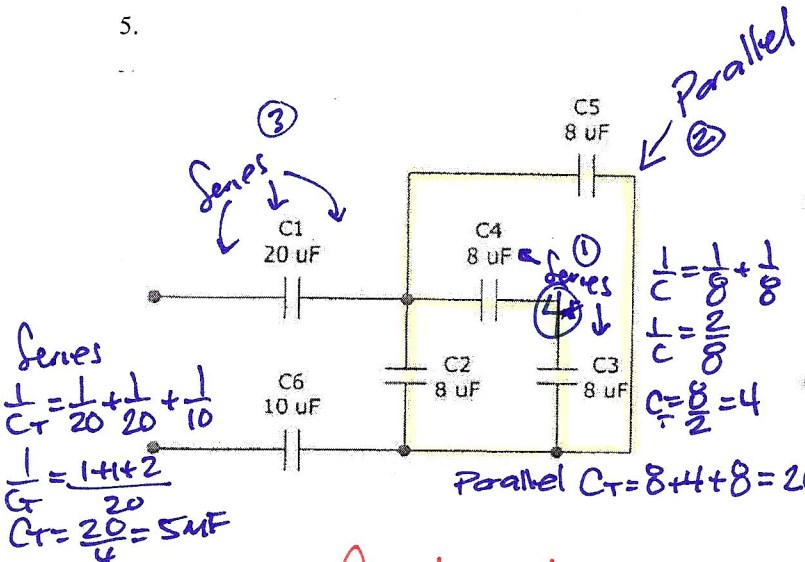
4.



Type of circuit: Combined

Total Capacitance: 3MF

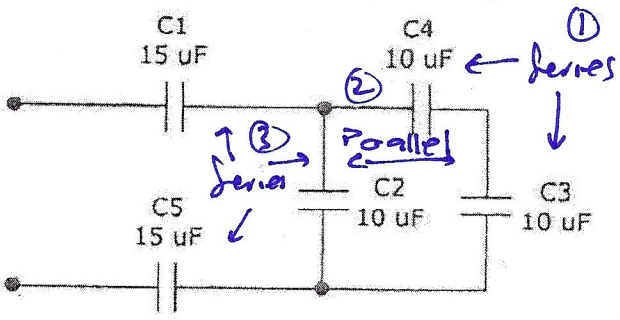
5.



Type of circuit: Combined

Total Capacitance: 5μF

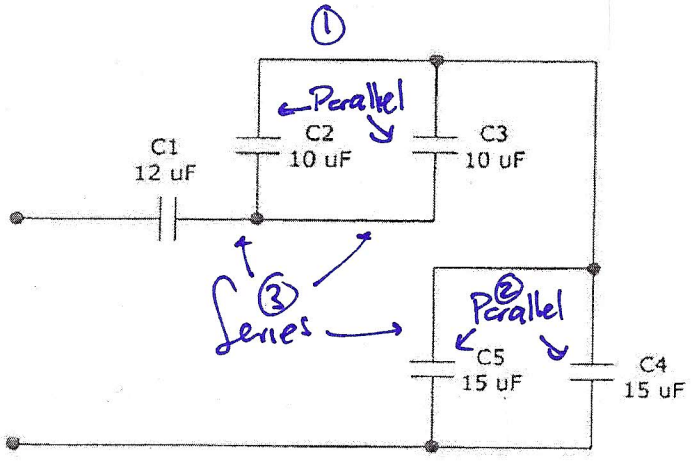
6.



Type of circuit: Combined

Total Capacitance: 5μF

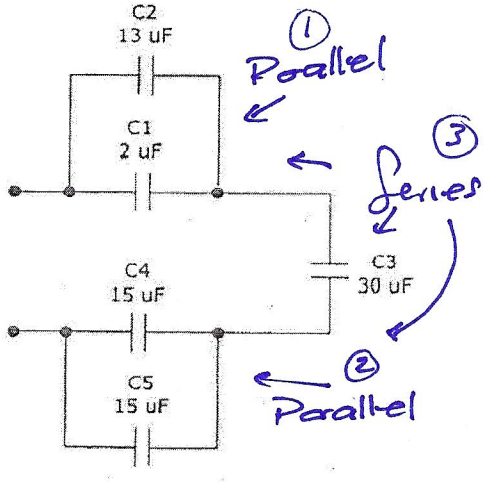
7.



Type of circuit: Combined

Total Capacitance: 6μF

8.

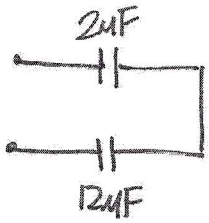


Type of circuit: Combined

Total Capacitance: 30/4μF = 7.5μF

Electric Potential & Capacitance II

1.



$\frac{1}{C_T} = \frac{3}{6}$

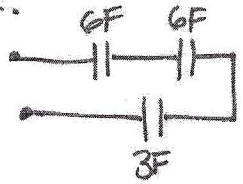
$C_T = \frac{6}{3} = 2\mu F$

$\frac{1}{C_T} = \frac{1}{2} + \frac{1}{12}$

$\frac{1}{C_T} = \frac{6+1}{12}$

$\boxed{C_T = 12/7 \mu F}$

2.



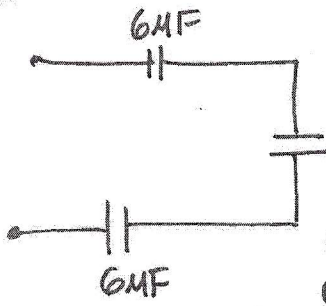
$\frac{1}{C_T} = \frac{1}{6} + \frac{1}{6} + \frac{1}{3}$

$\frac{1}{C_T} = \frac{1+1+2}{6}$

$\frac{1}{C_T} = \frac{4}{6}$

$C_T = \frac{6}{4} = \boxed{\frac{3}{2}\mu F}$

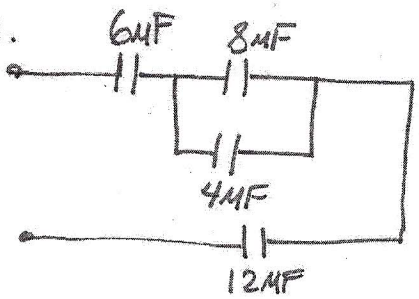
3.

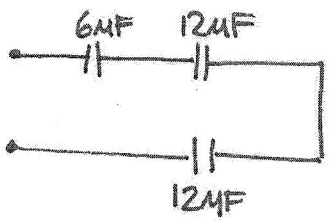


$\frac{1}{C_T} = \frac{3}{6}$

$C_T = \frac{6}{3} = \boxed{2\mu F}$

4.





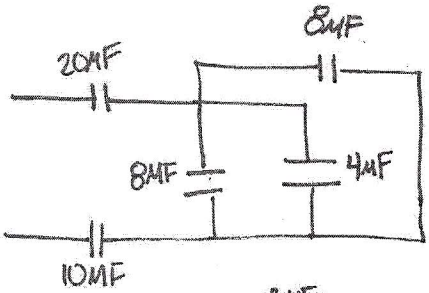
$\frac{1}{C_T} = \frac{1}{6} + \frac{1}{12} + \frac{1}{12}$

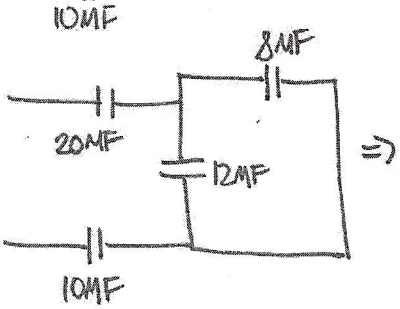
$\frac{1}{C_T} = \frac{2+1+1}{12}$

$\frac{1}{C_T} = \frac{4}{12}$

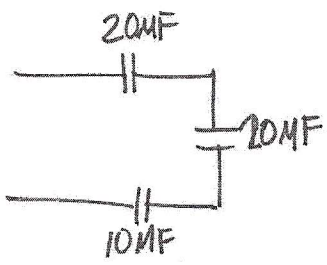
$C_T = \frac{12}{4} = \boxed{3\mu F}$

5.





⇒



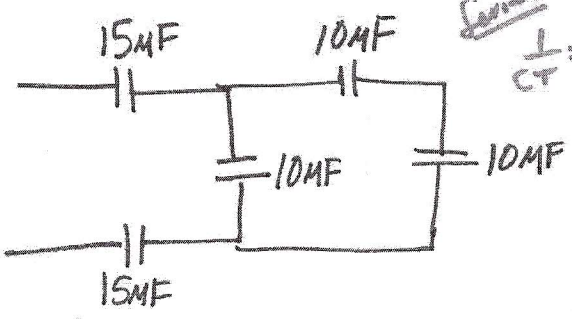
$\frac{1}{C_T} = \frac{1}{20} + \frac{1}{20} + \frac{1}{10}$

$\frac{1}{C_T} = \frac{1+1+2}{20}$

$\frac{1}{C_T} = \frac{4}{20}$ $\quad C_T = \frac{20}{4}$

$\boxed{C_T = 5\mu F}$

6.

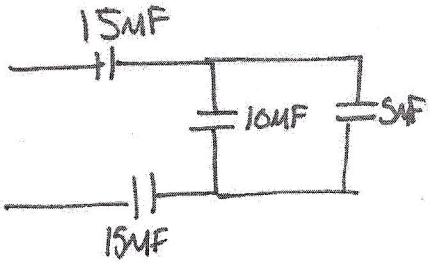


Series

$\frac{1}{C_T} = \frac{1}{10} + \frac{1}{20}$

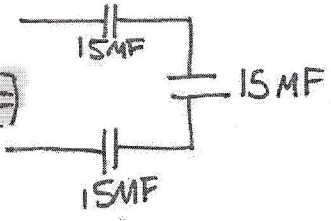
$\frac{1}{C_T} = \frac{2}{10}$

$C_T = \frac{10}{2} = 5$

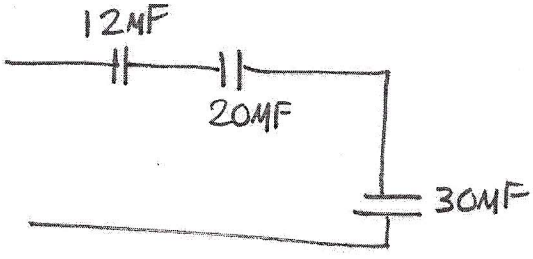


$\frac{1}{C_T} = \frac{3}{15}$

$C_T = \frac{15}{3} = 5MF$



(7)



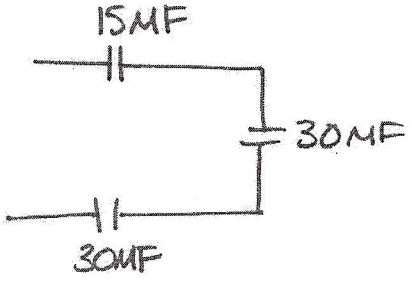
$\frac{1}{C_T} = \frac{1}{12} + \frac{1}{20} + \frac{1}{30}$

$\frac{1}{C_T} = \frac{5+3+2}{60}$

$\frac{1}{C_T} = \frac{10}{60}$

$C_T = 6MF$

(8)



$\frac{1}{C_T} = \frac{1}{15} + \frac{1}{30} + \frac{1}{30}$

$\frac{1}{C_T} = \frac{2+1+1}{30}$

$C_T = \frac{30}{4} = 7.5MF$

II. Answer the following. Show all your work

1. A 8 nanofarad parallel plate capacitor holds a charge of magnitude 45μC on each plate.
   a. What is the potential difference between the plates?
   b. If the plates are separated by a distance of 0.2mm, what is the area of the plate?
   c. What the electric potential energy stored in the capacitor?

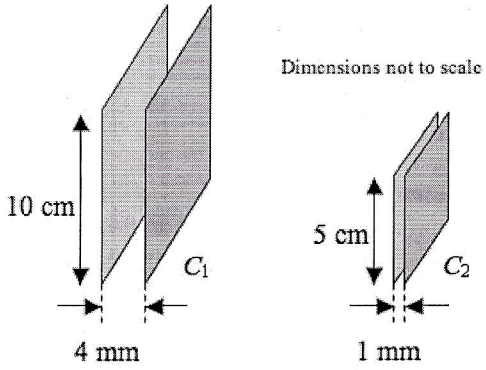
$C = 8nF = 8\times10^{-9}F$
$Q = 45mC = 45\times10^{-6}C$

a) $C = \frac{Q}{V}$
$V = \frac{Q}{C} = \frac{45\times10^{-6}C}{8\times10^{-9}F} = 5625V$

b) $C = \frac{\varepsilon_0 A}{d}$
$A = \frac{Cd}{\varepsilon_0} = \frac{(8\times10^{-9})(.0002)}{8.85\times10^{-12}} = 0.18\,m^2$

c) $U = \frac{1}{2}QV$
$U = \frac{1}{2}(45\times10^{-6})(5625)$
$U = 0.126\,J$

2. Capacitor C1 consists of square parallel plates 10cm on a side, and separated by a distance of 4mm, as shown. Capacitor C2 has squared parallel plates 5cm on a side, and separated by a distance of 1mm.
   a. What is the capacitance of the first capacitor? $2.21\times10^{-11}F$
   b. What is the capacitance of the second capacitor $2.21\times10^{-11}F$
   c. What is the ratio between the capacitances of the two parallel-plate systems? $[C_1:C_2]$ 1



a. $C_1 = \frac{\varepsilon_0 A}{d} = \frac{(8.85\times10^{-12})[(.1)(.1)]}{(.004)} = 2.21\times10^{-11}F$

b. $C_2 = \frac{\varepsilon_0 A}{d} = \frac{(8.85\times10^{-12})[(.05)(.05)]}{(.001)} = 2.21\times10^{-11}F$

$\frac{C_1}{C_2} = \frac{2.21\times10^{-11}}{2.21\times10^{-11}} = 1$

3. A capacitor is fully charged by a 10V battery and has 20miliJoules of energy stored in it..
   a. Find the charge on each conducting plate of the capacitor. $4\times10^{-3}C$
   b. Find the value of the capacitance. $4\times10^{-4}F$
   c. Find the separation of the plates is the surface area is $2.5mm^2$ $5.53\times10^{-14}m$

$V = 10V$
$U = 20mJ = 20\times10^{-3}J$

b) $C = \frac{Q}{V} = \frac{4\times10^{-3}}{10V} = 4\times10^{-4}F$

a) $U = \frac{1}{2}QV$
$Q = \frac{2U}{V} = \frac{2(20\times10^{-3})}{10}$
$Q = 0.004C = 4\times10^{-3}C$

c) $C = \frac{\varepsilon_0 A}{d}$

$= 2.5mm^2\left(\frac{1m}{1000mm}\right)^2$
$= 2.5\times10^{-6}m^2$

$d = \frac{\varepsilon_0 A}{C} = \frac{(8.85\times10^{-12})(2.5\times10^{-6})}{4\times10^{-4}} = 5.53\times10^{-14}m$