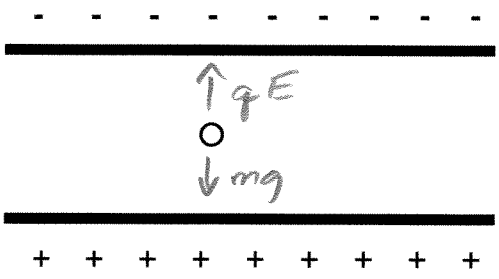
Physics 10164 - Exam 1D

Partial credit will be given provided you show all work and are solving parts of the problem correctly. Points will be deducted if you don't show your work even if you get the right answer. Clearly indicate your answer with a circle or a box and remember to include correct units and significant figures.

1. (30 pts) A 25-gram particle with a 42 μC charge is initially at rest at the midpoint between the two plates of a capacitor as shown below. The capacitor plates are separated by 7.0 mm, and the capacitor is connected to a 12 Volt source that charges the plates. You may assume both gravity and the electric force are relevant in this problem.

a) Which plate does the particle move towards?

b) How long (sec) does it take the charge to reach that plate?



$F_E = qE = q\frac{\Delta V}{d}$

$= \frac{(42\times10^{-6})(12)}{.007} = .072\,N$

$F_{grav} = mg = (.025)(9.8) = 0.245\,N$

$F_{grav} > F_E$, so particle moves down toward + plate

b) $\Sigma F = ma$ (assume down is positive)

$mg - qE = ma$

$.245 - .072 = .025a$

$a = 6.92\ m/s^2$

$\Delta y = v_0 t + \frac{1}{2}at^2$

$.0035 = 0 + \frac{1}{2}(6.92)t^2$

$t = .032\,s$

or $W_{grav} = mgh$

$= (.025)(9.8)(.0035)$

and $W_E = -q\Delta V$

$= -(42\times10^{-6})(6\,V)$

moving only ½ distance between plates

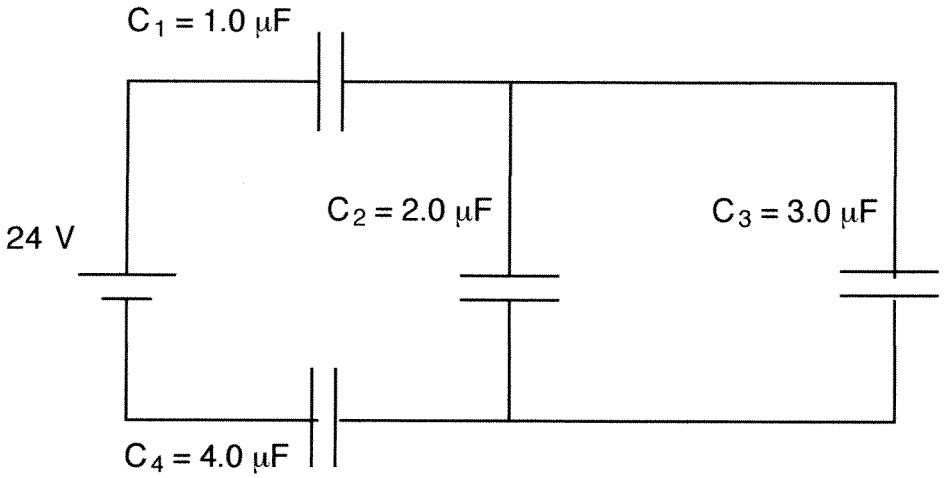
so $E\cdot d = \left(\frac{12}{.007}\right)(.0035)$

$= 6$

2. (40 pts) A -4.0 μC particle is fixed at the origin, and a 5.5 μC charge is fixed at the coordinates (x,y) = (1.50,0.00) meters. What is the magnitude and direction of the net electric force on a 2.2 μC charge located at coordinates (x,y) = (1.50,2.40) meters?

(see exam 1B)

3. (30 pts) Determine the charge on each capacitor in the circuit shown below. Show/explain all work.



$C_2 + C_3$ are parallel $C_{23} = 5.0\mu F$

C_1, C_{23}, C_4 are series $\frac{1}{C_{TOT}} = \frac{1}{1} + \frac{1}{5} + \frac{1}{4}$

$C_{TOT} = 0.69\mu F$

$\Delta V_{TOT} = 24\,V$

series

$\Rightarrow Q_{TOT} = 16.55\mu C = Q_1 = Q_{23} = Q_4$

$C_1 = 1.0\mu F$ $C_{23} = 5.0\mu F$ $C_4 = 4.0\mu F$

$\Delta V_1 =$ $\Delta V_{23} =$ $\Delta V_4 =$

$Q_1 = 16.55\mu C$ $Q_{23} = 16.55\mu C$ $Q_4 = 16.55\mu C$

$\Rightarrow \Delta V_1 = 16.55V$ $= \Delta V_{23} = 3.31\,V$ $\Delta V_4 = 4.14\,V$

parallel $\begin{cases} = \Delta V_2 \\ = \Delta V_3 \end{cases}$

$Q_1 = 16.55\mu C$

$Q_2 = C_2 \Delta V_2 = (2.0)(3.31) = 6.6\mu C$

$Q_3 = C_3 \Delta V_3 = (3.0)(3.31) = 9.9\mu C$

$Q_4 = 16.55\mu C$