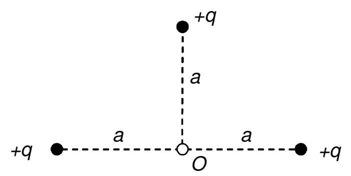
UNIVERSIDAD POLITECNICA DE VALENCIA	Retaking First exam FFI **January 27th 2014** Year 2013/14	Applied Physics Dept.

1.Three equal point charges **+q** are resting and placed as can be seen on picture, at a distance **a** from point O. Compute: a) The total electric force that such charges will produce on a charge **q'** placed on O. b) The electrostatic potential energy having **q'** on O. **2 points**	**1.**Tres cargas puntuales iguales de valor **+q** se encuentran en reposo, situadas como se ve en la figura, a una distancia **a** del punto O. Calcula: a) la fuerza eléctrica total que las cargas producirán sobre una carga **q'** situada en O. b) La energía potencial electrostática de **q'** en O. **2 puntos**	

a) The force produced on q' by those charges located on horizontal axis are cancelled, and then the only force acting on q' is due to the upper charge: $F_{q'} = k\dfrac{q \cdot q'}{a^2}$ N pointing to down if q' is positive.

b) The electric potential produced on O by the charges is: $V_O = 3k\dfrac{q}{a}$ V

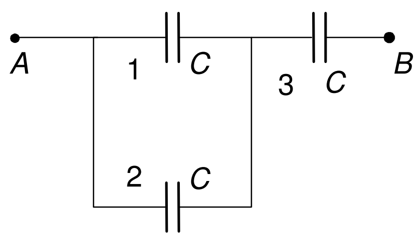
And the electrostatic potential energy of q' on O: $U_{q'} = q'V_O = q'3k\dfrac{q}{a} = \dfrac{3kqq'}{a}$ J

2. From a conductor material having resistivity **ρ**, two cylindrical wires with the same length **L** are built, but with different radii **R** and **2R** each. Both wires are connected in series, and a voltage **V** is applied to this set. Compute the intensity of current flowing along each wire. **1,5 points**	**2.** De un material conductor de resistividad **ρ** se fabrican dos cables cilíndricos de la misma longitud **L**, pero de radios **R** y **2R** cada uno de ellos. Se conectan en serie, y al conjunto se le aplica una tensión **V**. Calcular la corriente que circula por cada uno de los cables. **1,5 puntos**

Resistances of both wires are: $R_a = \rho\dfrac{L}{\pi R^2}\,\Omega$ and $R_{2a} = \rho\dfrac{L}{\pi(2R)^2} = \rho\dfrac{L}{4\pi R^2}\,\Omega$

When both wires are connected in series, the total resistance is $R = R_a + R_{2a} = \dfrac{\rho L}{\pi R^2}(1+\dfrac{1}{4}) = \dfrac{5\rho L}{4\pi R^2}\,\Omega$

And the intensity of current is the same for both wires: $I = I_a = I_{2a} = \dfrac{V}{R} = \dfrac{4V\pi R^2}{5\rho L}\,A$

3. Between points A and B of shown set of capacitors, a difference of potential **V** is applied. Three capacitors are equal, with capacitance **C**. Find: a) Charge on each capacitor. b) Difference of potential between terminals of each capacitor. c) Stored energy on capacitor 2. Results must be given as a function of **C** and **V**. **2 points**	**3.** Entre los puntos A y B de la asociación de condensadores de la figura se aplica una diferencia de potencial *V*. Los tres condensadores son iguales, de capacidad **C**. Halla: a) La carga en cada condensador. b) La diferencia de potencial entre los bornes de cada condensador. c) La energía almacenada en el condensador 2. Los resultados deben darse en función de **C** y **V**. **2 puntos**	

a) If Q_1, Q_2 and Q_3 and V_1, V_2 and V_3 are the charge and potential on each capacitor is verified that:

About charges: $Q_1=Q_2$ $Q_1+Q_2=Q_3$
About potentials: $V_1=V_2$ $V_1+V_3=V$ or $V_2+V_3=V$

From charges: $2Q_1 = Q_3 \Rightarrow Q_1 = \frac{Q_3}{2}$ and replacing on equation of potentials taking in account that

$$C = \frac{Q_1}{V_1} = \frac{Q_2}{V_2} = \frac{Q_3}{V_3}: \quad \frac{\frac{Q_3}{2}}{C} + \frac{Q_3}{C} = V \Rightarrow Q_3 = \frac{2}{3}CV \quad \text{and} \quad Q_1 = Q_2 = \frac{1}{3}CV$$

b) $V_1 = V_2 = \frac{1}{3}V$ and $V_3 = \frac{2}{3}V$

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a) can also be solved using the idea of equivalent capacitance:
Equivalet capacitance of 1 and 2 (they are in parallel) is $C_{12} = C + C = 2C$ This equivalent capacitor is in series with 3, being their equivalent capacitance $\frac{1}{C_{123}} = \frac{1}{C_{12}} + \frac{1}{C} = \frac{1}{2C} + \frac{1}{C} = \frac{3}{2C} \Rightarrow C_{123} = \frac{2}{3}C$

The charge taken by the equivalent capacitor is $Q_{123} = C_{123}V = \frac{2}{3}CV$

$$Q_3 = Q_{123} = \frac{2}{3}CV \quad \text{and} \quad Q_1 = Q_2 = \frac{1}{2}Q_3 = \frac{1}{3}CV$$

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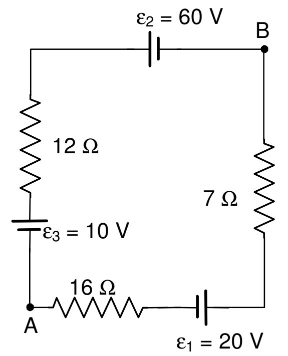
c) Stored energy on 2 is: $W_2 = \frac{Q_2^2}{2C} = \frac{C^2V^2}{9 \cdot 2C} = \frac{1}{18}CV^2$

4. On circuit on picture, compute:
a) Intensity of current flowing along circuit.
b) Difference of potential between points A and B.
c) Clearly state which devices on circuit are acting as generators and which are acting as receptors.
d) Consumed power on **7 Ω** resistor and generated power on **ε₁**.
2 points

4. En el circuito de la figura, calcula:
a) La intensidad de corriente del circuito.
b) La diferencia de potencial entre los puntos A y B.
c) Indica claramente qué elementos actúan como generadores y cuáles como receptores.
d) La potencia disipada en la resistencia de **7 Ω**, y la potencia generada por **ε₁**.
2 puntos

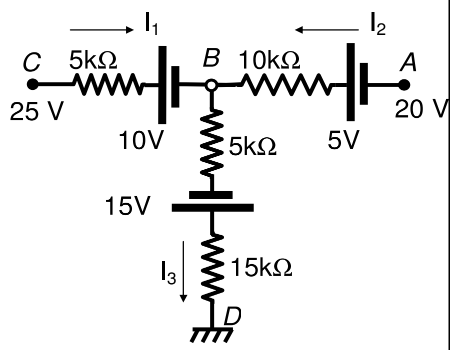


a) Assuming intensity flows in counterclockwise sense: $I = \frac{\sum_i \varepsilon_i}{\sum_j R_j} = \frac{60 - 10 + 20}{12 + 16 + 7} = \frac{70}{35} = 2\text{ A}$

b) $I = V_A - V_B = I\sum_{AB} R_j - \sum_{AB} \varepsilon_i = 2(16 + 7) - 20 = 26\text{ V}$

c) Generators (intensity flows from negative to positive terminal inside the device): ε_1 and ε_2
Receptors: ε_3

d) $P_R = I^2R = 2^27 = 28$ w $P_{\varepsilon 1} = 20*2 = 40$ w

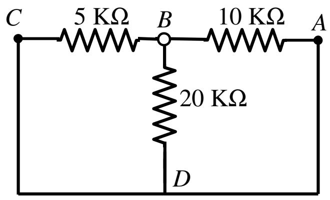
5. On circuit on picture, compute: a) Intensity of current flowing along each branch of circuit, with the shown senses. b) Difference of potential between points *A* and *B*. c) Equivalent resistance of passive circuit between points A and B. d) Drawn the equivalent Thevenin's generator between points A and B, clearly showing its polarity. **2,5 points**	**5.** Dado el circuito de la figura: a) Calcula la intensidad que circula por cada rama, con los sentidos indicados. b) Calcula la diferencia de potencial entre A y B. c) Calcula la resistencia equivalente del circuito pasivo entre A y B. d) Representa, indicando la polaridad, el generador equivalente de Thevenin entre A y B. **2,5 puntos**	

a) This is a network with 2 junctions and two loops, and so we'll need one equation for junctions and two equations for loops:

$$\left.\begin{aligned} I_1 + I_2 &= I_3 \\ V_{CD} = 25 &= I_1 5 - (-10) + I_3(15+5) - (15) \\ V_{AD} = 20 &= I_2 10 - (5) + I_3(15+5) - (15) \end{aligned}\right\} \Rightarrow I_1 = \frac{2}{7}\,mA \quad I_2 = \frac{8}{7}\,mA \quad I_3 = \frac{10}{7}\,mA$$

b) $V_A - V_B = 10 I_2 - (5) = \frac{45}{7}\,V$

c) Passive circuit and equivalent resistance between A and B (removing all the generators) is:



Between A and B, three resistors are in parallel: $\frac{1}{R_{eqAB}} = \frac{1}{5} + \frac{1}{10} + \frac{1}{20} \Rightarrow R_{eqAB} = \frac{20}{7}\,K\Omega$

d) So, Thevenin's equivalent generator between A and B is: