1. We want to design a spherical vacuum capacitor of a given radius a for the outer sphere, which will be able to store the greatest amount of electrical energy, subject to the constraint that the electric field strength at the surface of the inner sphere may not exceed E_o.
   (a) What radius b should be chosen for the inner spherical conductor?
   Ans: $b = \frac{3}{4}a$
   (b) How much energy can be stored?
   Ans: $U = 4\pi\epsilon_o \frac{27a^3 E_o^2}{512}$

2. An experimentalist observes a particle of charge q, mass m, and energy qV_o moving in a circular orbit of radius r_o inside a cylindrical capacitor with inner radius a and outer radius b, see Fig. (1).

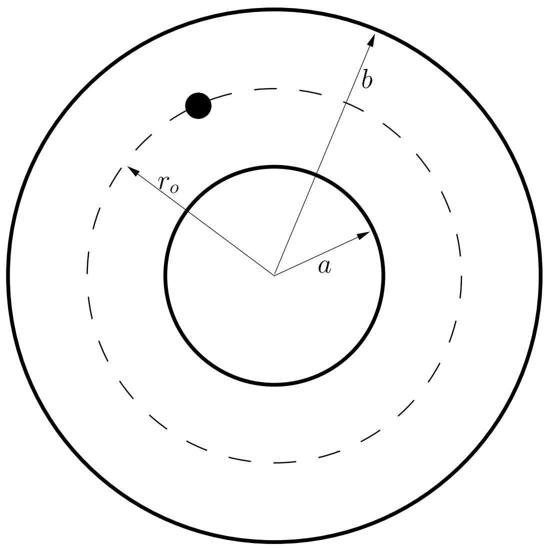

Figure 1: A particle of charge q, mass m, and energy qV_o moving inside a cylindrical capacitor is shown.

   (a) Assume the cylindrical capacitor is very long compared to the space between its walls, i.e., $\frac{b-a}{\ell} \ll 1$. Furthermore, assume that the moving particle has no effect on the cylindrical capacitor. Find the capacitance of the cylindrical capacitor.
   Ans: $C = \frac{2\pi\ell\epsilon_o}{\ln(b/a)}$
   (b) The experimentalist quickly observes that the particle only moves in a circular orbit with radius r_o when $V_a - V_b$ has a very special value. Find this value. (No, it's not zero.)
   Ans: $V_a - V_b = 2V_o \ln\left(\frac{b}{a}\right)$

3. Find the equivalent capacitance, C_{eq}, of the circuit shown in Fig. (2). Data: $C_1 = 1, C_2 = 2, C_3 = 3, C_4 = 4, C_5 = 5, C_6 = 6, C_7 = 7$.

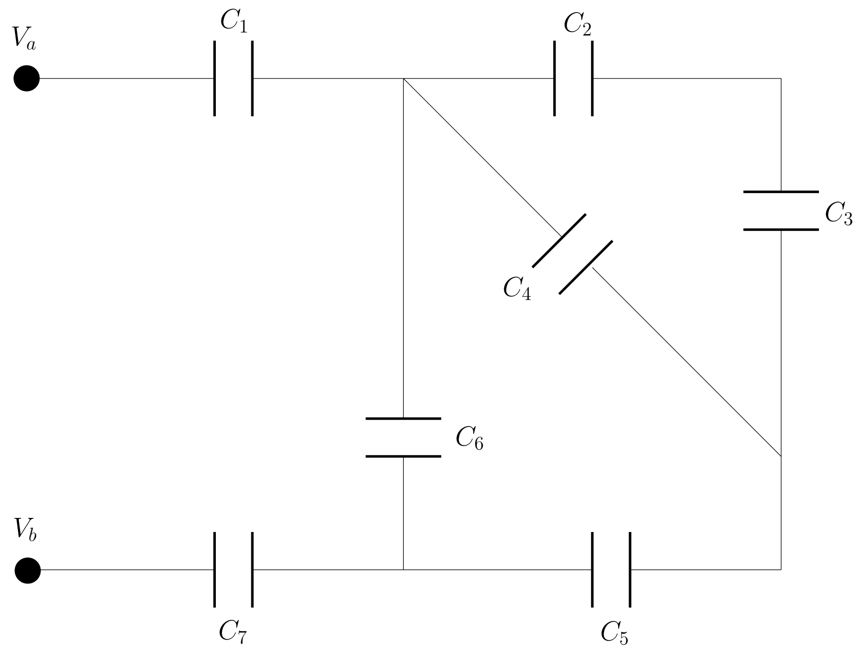

Figure 2: Find C_{eq} for this circuit. Hint: use color pencils/pens.

Ans: $C_{\text{eq}} = \frac{3052}{3845} \approx 0.794$

4. Prove that a network of capacitors **cannot** always be grouped into series and parallel combinations.

   Ans: Prove by counter example.