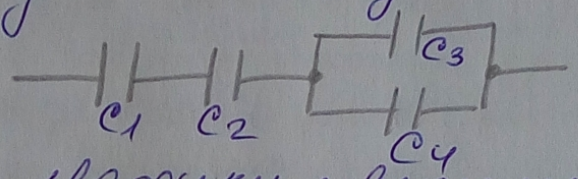
# Пример расчета

Таблица экспериментальных данных

| T, °C | 20 | 40 | 60 | 80 |
|---|---|---|---|---|
| $C_1$, пФ | 913,3 | 915,2 | 918,5 | 919,0 |
| $C_2$ пФ | 156,2 | 156,0 | 155,3 | 155,0 |
| $C_3$ пФ | 1569,3 | 1565,2 | 1559,2 | 1555,6 |
| $C_4$ пФ | 29,7 | 29,8 | 30,4 | 31,4 |

Схема соединения конденсаторов:




① Построим графики зависимости C от T
Определим ТКЕ для каждого конденсатора

$$ТКЕ = \frac{1}{C_{20}} \cdot \frac{C_{80} - C_{20}}{\Delta T} = m \cdot 10^{-6}$$

запишем в виде таком

$$ТКЕ_1 = \frac{1}{913,3} \cdot \frac{919,0 - 913,3}{80 - 20} = 104 \cdot 10^{-6} \left(\frac{1}{K}\right)$$

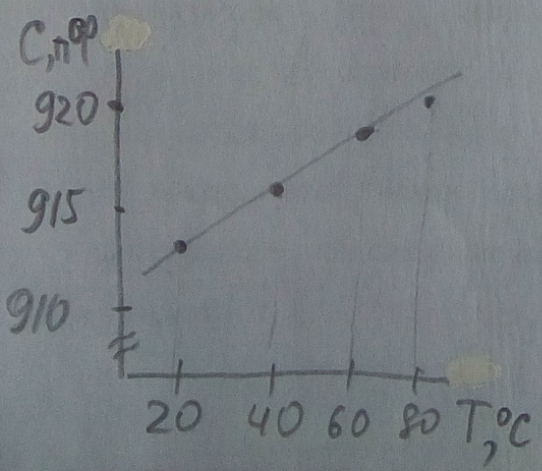
аналогично

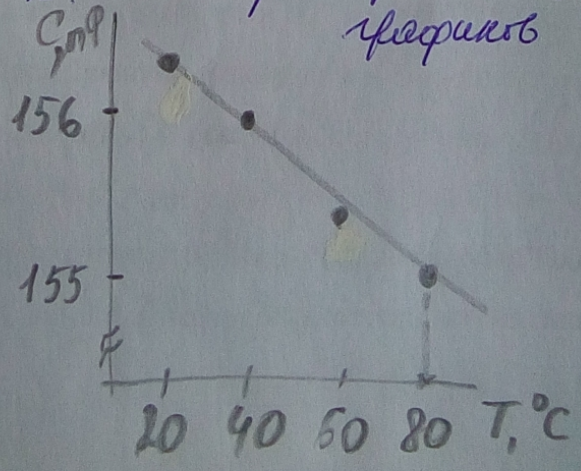
$$ТКЕ_2 = \frac{1}{156,2} \cdot \frac{155,0 - 156,2}{60} = -128 \cdot 10^{-6} \left(\frac{1}{K}\right)$$

$$ТКЕ_3 = -145 \cdot 10^{-6} \left(\frac{1}{K}\right)$$

$$ТКЕ_4 = 953 \cdot 10^{-6} \left(\frac{1}{K}\right)$$

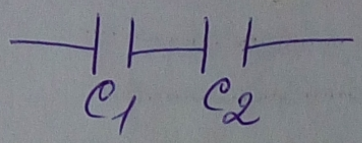
Пример построения графика C (T)



② Найдем ТКЕ первого и второго конденсаторы

В схеме они соединены последовательно




$$C_{1,2} = \frac{C_1 \cdot C_2}{C_1 + C_2}$$

$$C_{1,2} = \frac{913,3 \cdot 156,2}{913,3 + 156,2} = 133,4 \text{ пФ}$$

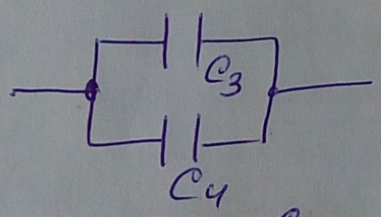
$$ТКЕ_{1,2} = \frac{C_{12}}{C_1} ТКЕ_1 + \frac{C_{12}}{C_2} \cdot ТКЕ_2$$

$$ТКЕ_{1,2} = \frac{133,4}{913,3} \cdot (104 \cdot 10^{-6}) + \frac{133,4}{156,2} \cdot (-128 \cdot 10^{-6}) = -94,2 \cdot 10^{-6}$$

контролируем $-128 < -94,2 < 104$

③ Найдем ТКЕ третьего и четвертого конденсаторы

В схеме они соединены параллельно




$$C_{3,4} = C_3 + C_4 = 1569,3 + 29,7$$

$$C_{3,4} = 1599 \text{ пФ}$$

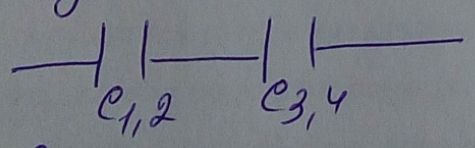
$$ТКЕ_{3,4} = \frac{C_3}{C_{3,4}} \cdot ТКЕ_3 + \frac{C_4}{C_{3,4}} \cdot ТКЕ_4$$

$$ТКЕ_{3,4} = \frac{1569,3}{1599} \cdot (-145 \cdot 10^{-6}) + \frac{29,7}{1599} \cdot (953 \cdot 10^{-6})$$

$$ТКЕ_{3,4} = -125 \cdot 10^{-6} \left(\frac{1}{K}\right)$$

$-145 < -125 < 953$

④ Найдем ТКЕ всех четырех конденсаторов




$$C_{1,2,3,4} = \frac{C_{12} \cdot C_{34}}{C_{12} + C_{34}}$$

$$ТКЕ_{1234} = \frac{C_{1234}}{C_{12}} ТКЕ_{12} + \frac{C_{1234}}{C_{34}} ТКЕ_{34}$$

$$C_{1234} = \frac{133,4 \cdot 1599}{133,4 + 1599}$$

$$C_{1234} = 123,2 \text{ пФ}$$

$$ТКЕ_{1234} = \frac{123,2}{133,4} \cdot (-94,2 \cdot 10^{-6}) + \frac{123,2}{1599} \cdot (-125 \cdot 10^{-6})$$

$$\boxed{ТКЕ_{1234} = -96,5 \cdot 10^{-6} \left(\frac{1}{K}\right)}$$

$-125 < -96,5 < -94,2$

5 Проверка.

Определим суммарное ТКЕ по формуле: $ТКЕ_{1234} = \frac{1}{C_{\Sigma 20}} \cdot \frac{C_{\Sigma 80} - C_{\Sigma 20}}{\Delta T}$, где

$C_{\Sigma 20}$ – суммарная емкость схемы при 20°C ($C_{1234}$)

$C_{\Sigma 80}$ – суммарная емкость схемы при 80°C ($C_{1234}^{(80)}$)

Рассчитаем $C_{\Sigma 80}$

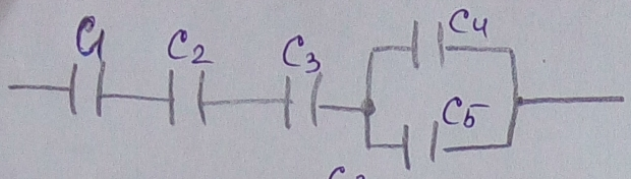
$$C_{12}^{(80)} \frac{919{,}0 \cdot 155{,}0}{919{,}0 + 155{,}0} = 132{,}6 \text{ пФ}$$

$$C_{34}^{(80)} = 1555{,}6 + 31{,}4 = 1587 \text{ пФ}$$

$$C_{1234}^{(80)} = \frac{132{,}6 \cdot 1587}{132{,}6 + 1587} = 122{,}4 \text{ пФ}$$

$$\boxed{ТКЕ = \frac{1}{123{,}2} \cdot \frac{122{,}4 - 123{,}2}{80 - 20} = -96{,}9 \cdot 10^{-6} \frac{1}{K}}$$

1

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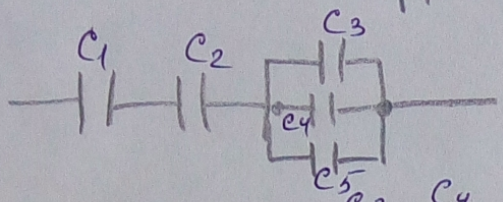


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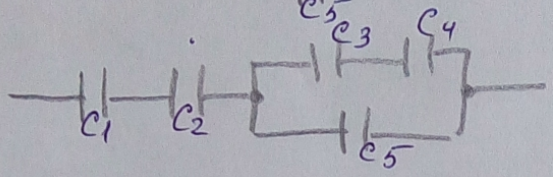


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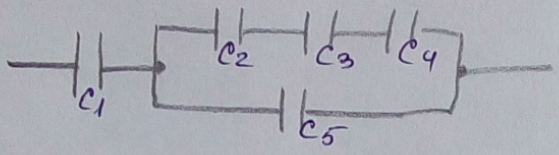


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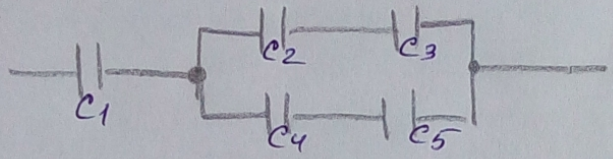


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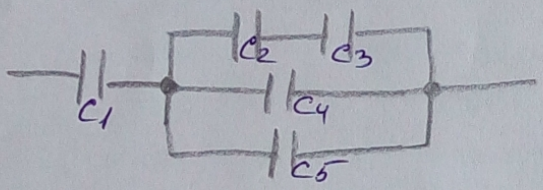


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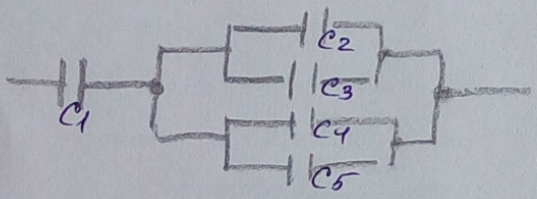


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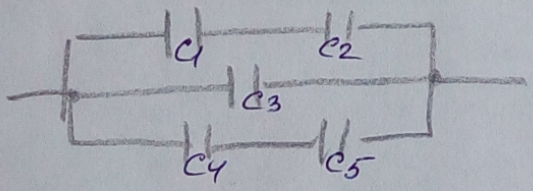


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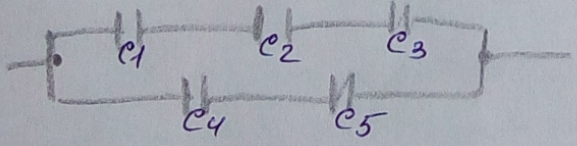


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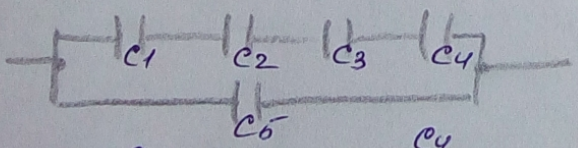


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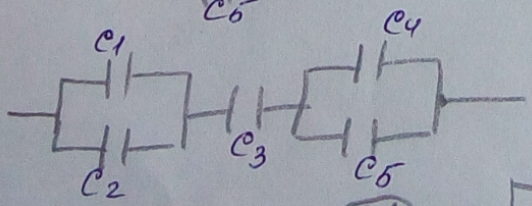


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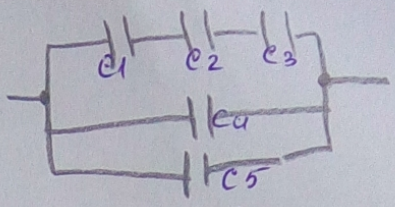


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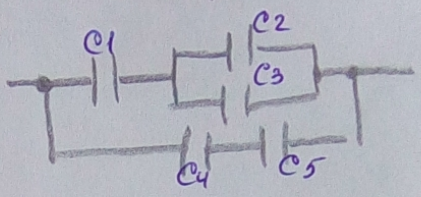


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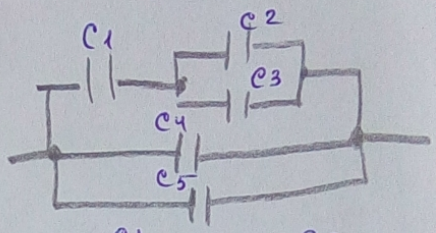


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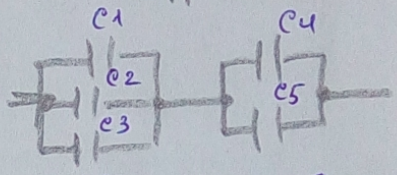


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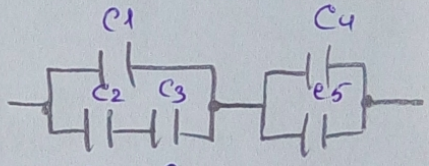


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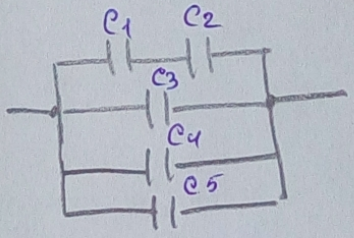


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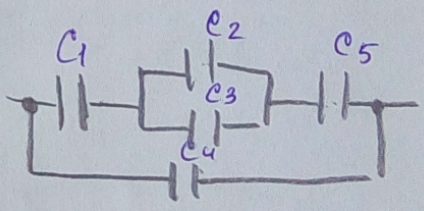


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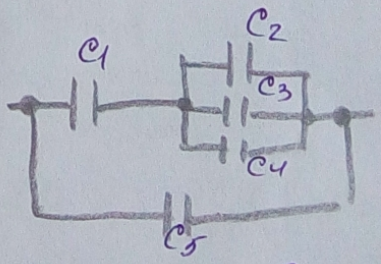


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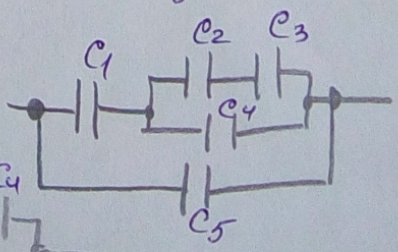

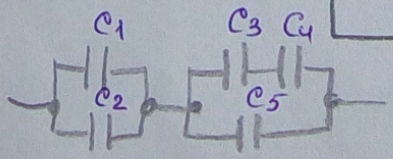
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