1. Consider a circuit of two capacitors in parallel: C1 and C2 (C1≠C2). Which one of the statements is correct?

(a) Q1=Q2  (b) $Q_1 \neq Q_2$  (c) $1/C_{eq} = 1/C_1 + 1/C_2$  (d) $V_1 \neq V_2$

Since $V$ is the same, $C = \frac{Q}{V} \Rightarrow Q = CV$

$Q_1 = C_1 V$; $Q_2 = C_2 V$, $C_1 \neq C_2 \Rightarrow Q_1 \neq Q_2$

2. Consider a circuit of two capacitors in series: C1 and C2 (C1≠C2). Which one of the statements is correct?

(a) $Q1 \neq Q2$  (b) $V1=V2$  (c) $V1 \neq V2$  (d) $C_{eq} = C1+C2$

$c$ is the same, $C = \frac{Q}{V} \Rightarrow V = \frac{Q}{C}$

$V_1 = \frac{Q}{C_1}$; $V_2 = \frac{Q}{C_2}$; $C_1 \neq C_2 \Rightarrow V_1 \neq V_2$

3. Consider a circuit of two resistors in series: R1 and R2 (R1≠R2). Which one of the statements is correct?

(a) $V1=V2$  (b) $R_{eq}=R1+R2$  (c) $I_1 \neq I_2$  (d) $1/R_{eq} = 1/R1 + 1/R2$

$R_{eq} = R_1 + R_2$

4. Consider a circuit of two resistors in parallel: R1 and R2 (R1≠R2). Which one of the statements is correct?

(a) $V1 \neq V2$  (b) $R_{eq}=R1+R2$  (c) $I_1=I_2$  (d) $V1=V2$

$V$ is the same

5. Consider a circuit of two resistors in parallel: R1 and R2 (R1=R2=R). Which one of the statements is correct?

(a) $I_1 \neq I_2$  (b) $V1 \neq V2$  (c) $R_{eq}=R/2$  (d) $R_{eq}=2R$  (e) $R_{eq}=R$

\[
\frac{1}{R_{eq}} = \frac{1}{R} + \frac{1}{R} = \frac{2}{R} \Rightarrow R_{eq} = \frac{R}{\frac{2}{R}}
\]
6. A current of 10 A flows through a filament of a heater. How many electrons flow through the filament in 160 s?

(a) \(1.6 \times 10^{19}\)  (b) \(1.6 \times 10^{19}\)  (c) \(1.0 \times 10^{29}\)  (d) \(1.0 \times 10^{22}\)  (e) \(2.6 \times 10^6\)  (f) 1600

\[
I = \frac{\Delta Q}{\Delta t} \quad \Rightarrow \quad \Delta Q = I \Delta t = 10 \times 160 = 1600 C
\]

\[
q = 1.6 \times 10^{-19} C, \quad \text{# of electrons} = \frac{1600}{1.6 \times 10^{-19}} = 10^{22}
\]

7. Two capacitors are identical. They can be connected in series or in parallel. If you want the smallest equivalent capacitance for the combination, how should you connect them? C₁ = C₂ = C

(a) in series  (b) in parallel  (c) both configurations will have the same equivalent capacitance

\[
C^P = C_1 + C_2 = 2C \quad \quad C^S = \left(\frac{1}{C_1} + \frac{1}{C_2}\right)^{-1} = \left(\frac{2}{C}\right)^{-1} = \frac{C}{2}
\]

8. Two resistors are identical. They can be connected in series or in parallel. If you want the smallest equivalent resistance for the combination, how should you connect them? R₁ = R₂ = R

(a) in series  (b) in parallel  (c) both configurations will have the same equivalent resistance

\[
R^S = R_1 + R_2 = 2R \quad \quad R^P = \left(\frac{1}{R_1} + \frac{1}{R_2}\right)^{-1} = \left(\frac{2}{R}\right)^{-1} = \frac{R}{2}
\]

9. Three resistors (3.0 Ω, 6.0 Ω, and 9.0 Ω) are connected in parallel, and the resulting combination is connected to a battery that supplies 18.0 V. What is the equivalent resistance of the circuit (in units of Ω)?

(a) 18  (b) 6  (c) 2.88  (d) 1.64  (e) 0.61  (f) 0

\[
18 \, V
\]

\[
R_{eq}^P = \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)^{-1} = \left(\frac{1}{3} + \frac{1}{6} + \frac{1}{9}\right)^{-1} = 1.64 \, \Omega
\]

10. Two capacitors (C₁=5.0 μF, and C₂=12.0 μF) are connected in parallel, and the resulting combination is connected to a 9.0 V battery. Find the charge stored on each capacitor (in units of μF).

(a) 20, 30  (b) 100, 208  (c) 45, 108  (d) 5, 12  (e) 12, 5

\[
\begin{align*}
C_1 &= \frac{Q}{V} \quad \Rightarrow \quad Q = CV \\
C_2 &= \frac{Q}{V} \quad \Rightarrow \quad Q = CV
\end{align*}
\]

\[
Q_1 = C_1 V = 5 \times 10^{-6} \times 9 = 45 \mu F
\]

\[
Q_2 = C_2 V = 12 \times 10^{-6} \times 9 = 108 \mu F
\]

11. A conducting wire of length 1.0 m, radius 0.321x10⁻³ m, and conductivity σ=6.67x10⁵ (Ω m)⁻¹ is connected to a battery that maintains 10 V across that wire. What is the current in the wire (in units of A)?
(a) 4.6  (b) 2.2  (c) 12  (d) 1.6x10^{-19}  (e) 10  (f) 0.45

\[ \Delta V = RI \Rightarrow I = \frac{\Delta V}{R} \]

\[ R = \frac{P}{\frac{P}{L}} \]

\[ \rho = \frac{1}{\sigma} \]

\[ R = \frac{l}{\pi \rho A} \]

\[ A = \pi r^2 \]

Then \[ R = \frac{l}{\pi \rho A} \]

\[ R = \frac{P}{6.67 \times 10^{-8} \times 3.14 \times (0.32 \times 10^{-3})^2} = 4.64 \Omega \]

Finally \[ I = \frac{10}{4.64} = 2.2 \text{ A} \]

12. Two lightbulbs of power of 30 W and 60 W respectively are connected to a 120 V battery (see figure). What is the current in the 30 W and the 60 W light bulbs (in units of A)?

(a) 0.8, 0.15  (b) 0.4, 0.8  (c) 0.25, 0.5  (d) 0.6, 1.2  (e) 3, 6  (f) 30, 60

\[ P = IV \Rightarrow I = \frac{P}{V} \]

\[ I_{30} = \frac{30}{120} = 0.25 \text{ A} \]

\[ I_{60} = \frac{60}{120} = 0.5 \text{ A} \]

13. Three resistors (3.0 Ω, 6.0 Ω, and 9.0 Ω) are connected in parallel, and the resulting combination is connected to a battery that supplies 18.0 V. What is the total power delivered by the battery to the combination of resistors?

(a) 100 W  (b) 0.6 W  (c) 18 W  (d) 325 W  (e) 198 W  (f) 120 W  (g) 240 W

\[ R_{eq}^P = \left( \frac{1}{3} + \frac{1}{6} + \frac{1}{9} \right)^{-1} = 1.64 \Omega \]

\[ P = \frac{18^2}{1.64} = 198 \text{ W} \]

14. Which material has the best conductivity? (Circle one)

<table>
<thead>
<tr>
<th>Material</th>
<th>Resistivity (Ω m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron</td>
<td>10x10^{-8}</td>
</tr>
<tr>
<td>Copper</td>
<td>1.7x10^{-8}</td>
</tr>
<tr>
<td>Silicon</td>
<td>2.3x10^{-7}</td>
</tr>
<tr>
<td>Glass</td>
<td>10x10^{12}</td>
</tr>
</tbody>
</table>

\[ \rho = \frac{I}{\sigma} \Rightarrow \sigma = \frac{I}{\rho} \]

The lower the resistivity, the higher the conductivity.

15. The Figure shows four parallel plate capacitors: A, B, C, D. Each capacitor carries the same amount of charge Q and has the same plate area A.

Which list below places the capacitors in order of increasing (i.e. low to high) capacitance?
16. We have an RC circuit which is connected to a battery that supplies a voltage $E=1.5$ V. It takes $32 \times 10^{-3}$ s to partially charge a capacitor to $q=2.6 \times 10^{-6}$ C. The maximum charge that can be charged on that capacitor is $3 \times 10^{-6}$ C. What is the resistance (in units of $\Omega$)?

(a) $3 \times 10^3$  (b) $8 \times 10^1$  (c) $3 \times 10^{13}$  (d) $8 \times 10^3$  (e) $2.6 \times 10^6$  (f) $32 \times 10^{-3}$

\[
\frac{q(t)}{E} = \frac{Q_{\text{max}}(1-e^{-t/RC})}{EC}\]

Solving for $RC$, \[e^{-t/RC} = 1 - \frac{q}{Q_{\text{max}}}\] taking $\ln$ \[RC = \frac{-t}{\ln\left(1 - \frac{q}{Q_{\text{max}}}\right)}\]

\[
RC = \frac{-2.6 \times 10^{-6}}{\ln\left(1 - \frac{2.6 \times 10^{-6}}{3 \times 10^{-6}}\right)} = 0.016 \quad \Rightarrow \quad RC = \frac{E}{Q_{\text{max}}} = \frac{1.5}{3 \times 10^{-6}} = 2 \times 10^{-6} \Omega \]

17. In the headlamp of an automobile, a current of 8.0 A flows through the filament of the lightbulb. How much electric charge flows through the filament in 60 s (in units of C)?

(a) 840  (b) 240  (c) 120  (d) 48  (e) 480  (f) 420  (g) 0.5

\[
I = \frac{dQ}{dt} \quad \Rightarrow \quad \Delta Q = I \Delta t = 8 \times 60 = 480 \text{ C}
\]

18. To measure the resistance of a long piece of cable, an engineer connects this wire between the terminals of a 6.0 V battery. She finds that this produces a current of 30 A in the wire. What is the resistance of the wire (in units of $\Omega$)?

(a) 0.1  (b) 0.8  (c) 0.2  (d) 2  (e) 1  (f) 6  (g) 30

\[
V = IR \quad \Rightarrow \quad R = \frac{V}{I} = \frac{E}{\Delta Q} = 0.2 \Omega
\]