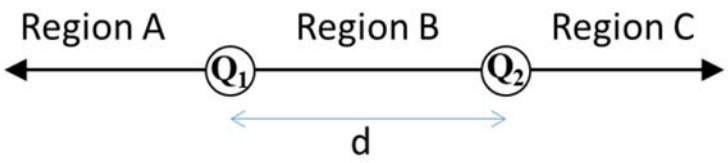
The next three questions pertain to the situation described below.

A positive and a negative charge have mass 0.4 kg and are fixed in position along the x-axis separated by a distance d=0.2 m as shown in below.



$Q1=8.2 \times 10^{-6}$ Coulombs
$Q2=-1.64 \times 10^{-5}$ Coulombs
d =0.2 m
m =0.4 kg

1) If charge Q2 is released from rest, how fast will it be moving when it is a distance d/4 from charge Q1?

a. 11 m/s
b. 12.3 m/s
c. 5.5 m/s
d. 9.53 m/s
e. 0 m/s

2) In which region(s) is there a point on the x-axis where the electric field due to the two charges is zero?

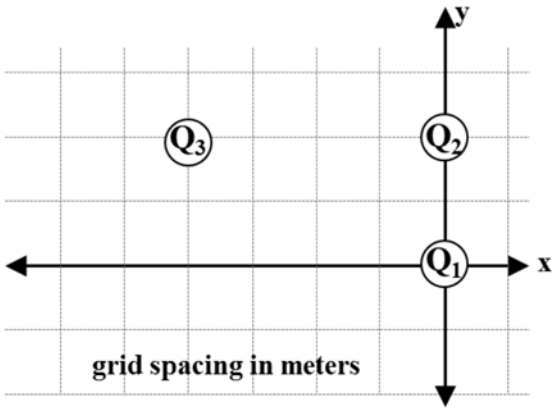
a. Region A only
b. Region A and B.
c. Region B only.

3) In which region(s) is there a point on the x-axis where the electric potential due to the two charges is zero?

a. Region B only.
b. Region A only.
c. Regions A and B.

The next three questions pertain to the situation described below.

Three charges are fixed in position as shown in below. Note, charges Q1 and Q3 are positive, charge Q2 is negative.



Q1=2.4 × 10^{-6} Coulombs
Q2=-4.8 × 10^{-6} Coulombs
Q3=2.4 × 10^{-6}Coulombs

4) What is the x component of the force on charge Q1 due to the other two charges?

a. F_{1x} = -0.0236 N
b. F_{1x} = 0.00116 N
c. F_{1x} = 0.00232 N
d. F_{1x} = 0.00259 N
e. F_{1x} = -0.0259 N

5) What is the y component of the force on charge Q1 due to the other two charges?

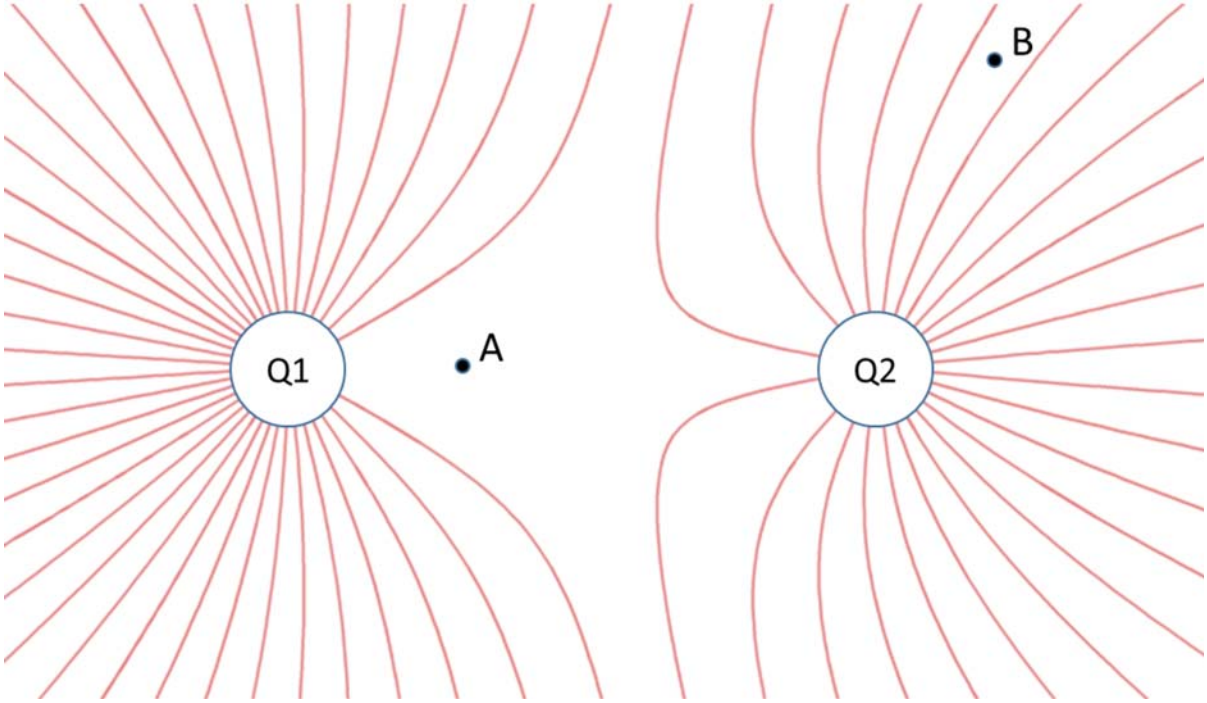
a. F_{1y} = 0.0233 N
b. F_{1y} = -0.0233 N
c. F_{1y} = 0.0224 N
d. F_{1y} = -0.0282 N
e. F_{1y} = 0.0248 N

6) How much work does the **electric field** do,when the charges are brought from infinitely far away, to their location in the figure.

a. W_E = -0.0143 J
b. W_E = -0.0662 J
c. W_E = 0.0662 J
d. W_E = 0.0143 J
e. W_E = 0 J

The next two questions pertain to the situation described below.

The figure below shows the field lines due to two unknown point charges.



7) Compare the magnitude of the two charges.

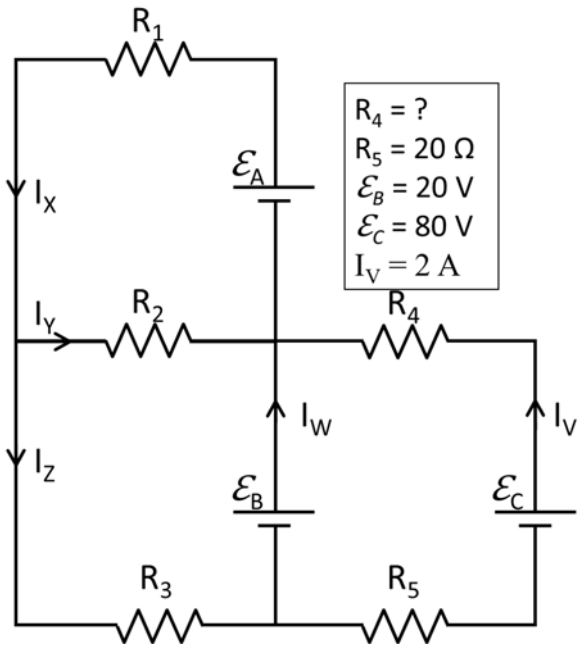
a. $|Q1| < |Q2|$
b. $|Q1| > |Q2|$
c. $|Q1| = |Q2|$

8) Compare the magnitude of the electric field at points **A** and **B**.

a. $|E_A| > |E_B|$
b. $|E_A| = |E_B|$
c. $|E_A| < |E_B|$

The next three questions pertain to the situation described below.

Consider the circuit shown below.



9) What is the resistance of resistor R_4?

a. $R_4 = 5\ \Omega$
b. $R_4 = 10\ \Omega$
c. There is no value of R_4 for which $I_V = 2$ A.
d. $R_4 = 20\ \Omega$
e. $R_4 = 2\ \Omega$

10) Which of the following equations is a valid application of Kirchhoff's current law?

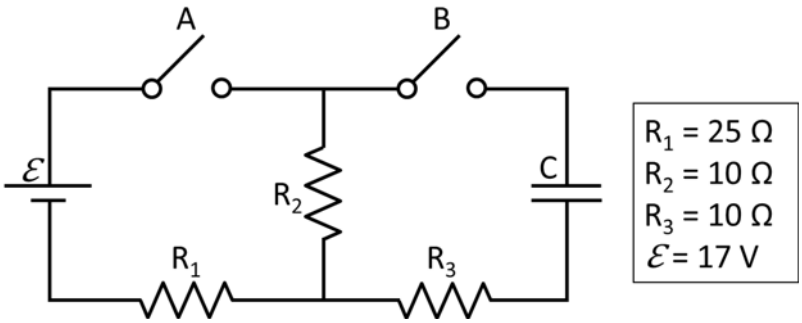
a. $I_x + I_y = I_z$
b. $I_z = I_w - I_v$
c. $I_y + I_w + I_v - I_x = 0$

11) Which of the following equations is **NOT** a valid application of Kirchhoff's voltage law?

a. $\varepsilon_A + \varepsilon_B - I_x R_1 - I_z R_3 = 0$
b. $\varepsilon_B - I_y R_2 - I_z R_3 = 0$
c. $\varepsilon_A - I_x R_1 - I_y R_2 = 0$

The next four questions pertain to the situation described below.

Consider the circuit shown below. Initially, both switches are open and the capacitor has been charged to 10 Volts.

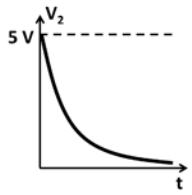


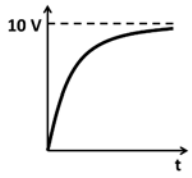
At time t=0 switch B is closed (switch A remains open).

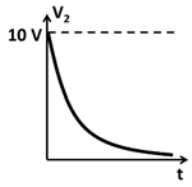
12) What is the current through resister R_3 just after the switch B is closed?

a. $I_3 = 1.5$ A.
b. $I_3 = 0.5$ A.
c. $I_3 = 2.5$ A.

13) Which of the following plots best represents the voltage V_2 across resistor 2 starting just after switch B is closed? (Be careful image is above answer choice)

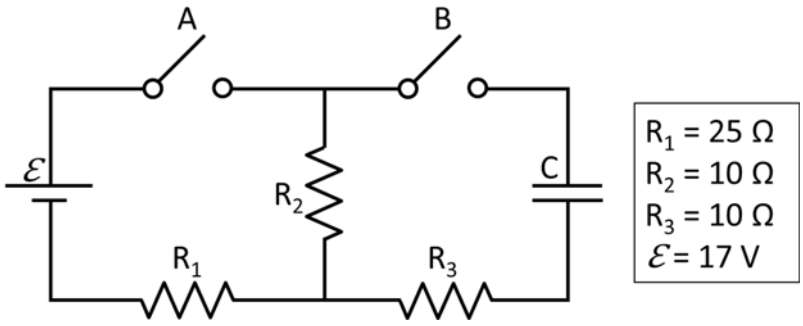
a.


b.


c.


14) **Figure repeated from previous page**

Consider the circuit shown below. Initially, both switches are open and the capacitor has been charged to 10 Volts. At time t=0 switch B is closed (switch A remains open).



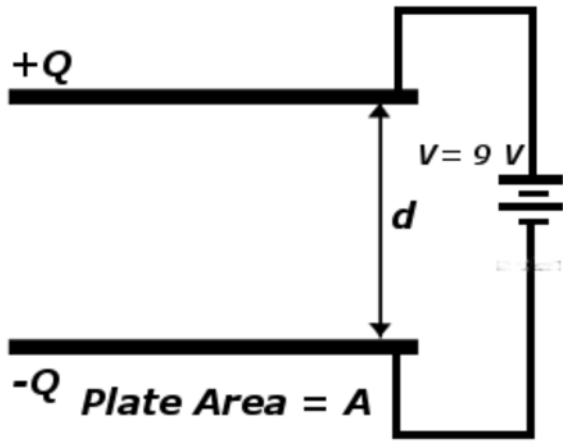
If it takes 12 μs for the charge on the capacitor to drop the 1/2 of its initial value, what is the capacitance of the capacitor C?

a. C = 1631 nF
b. C = 493 nF
c. C = 3370 nF
d. C = 866 nF
e. C = 215 nF

15) After a very long time, switch A is closed. Switch B remains closed. What is the magnitude of the current I_1 through resistor R_1 immediately after switch A is closed?

a. I_1 = 0.567 A
b. I_1 = 0.165 A
c. I_1 = 0.202 A
d. I_1 = 0.446 A
e. I_1 = 0.930 A

The next three questions pertain to the situation described below.



A parallel plate capacitor consists of two metal plates with an area $A = 542\ mm^2$ separated by a distance $d = 0.36\ mm$. The capacitor is connected to a 9 volt battery as shown above.

16) What is the charge Q on the capacitor?

a. $Q = 0.539\ nC$
b. $Q = 1.08\ nC$
c. $Q = 120\ nC$
d. $Q = 0.12\ nC$
e. $Q = 1.2 \times 10^{-4}\ nC$

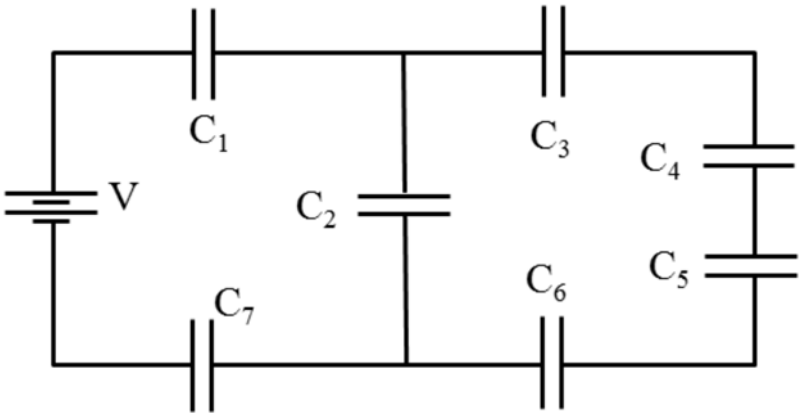
17) If the plates are pulled slightly further apart (increasing *d*) the magnitude of the *electric field* between the plates

a. decreases.
b. remains the same.
c. increases.

18) If a dialectric of dialectric strength κ is placed between the plates, how will the charge on the capacitor change?

a. *decrease by a factor of κ.*
b. *Stay the same.*
c. *Increase by a factor of κ.*

The next four questions pertain to the situation described below.



Seven identical capacitors with capacitance C = 8.5 nF are connected to a 12 Volt battery as shown in the figure above.

19) Capacitors C_3 and C_6 are connected

a. in parallel.
b. in series.
c. neither in series nor in parallel.

20) Compare the magnitude of the voltage across capacitor C_1 with the magnitude of the voltage across capacitor C_7

a. $V_1 = V_7$
b. $V_1 > V_7$
c. $V_1 < V_7$

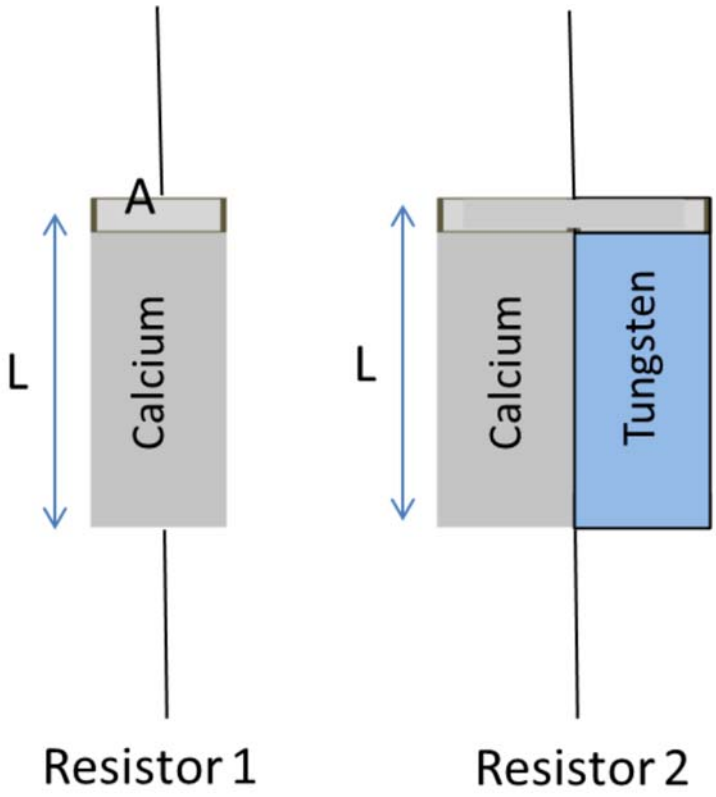
21) What is the equivalent capacitance of the network of seven capacitors?

a. $C_{eq} = 9.92$ nF
b. $C_{eq} = 9.07$ nF
c. $C_{eq} = 23.8$ nF
d. $C_{eq} = 3.04$ nF
e. $C_{eq} = 1.21$ nF

22) What is the voltage across capacitor C_2?

a. $V_2 = 3.4$ Volts
b. $V_2 = 4$ Volts
c. $V_2 = 0.85$ Volts

The next two questions pertain to the situation described below.



A student decides to build some resistors using rectangular blocks of calcium ($\rho = 3.36 \times 10^{-8}$ Ω m) and tungsten ($\rho = 5.6 \times 10^{-8}$ Ω m). The dimensions of the blocks are identical with a length L = 0.12 m, and cross section A = 2.25×10^{-4} m^2. Resistor 1 is created from a single block of calcium. Resistor 2 is created by attaching a block of calcium to a block of tungston as shown in the figure above.

23) Compare the resistance of the two resistors.

a. $R_1 = R_2$
b. $R_1 > R_2$
c. $R_1 < R_2$

24) What is the resistance of resistor 2?

a. $R_2 = 1.12 \times 10^{-5}$ Ω
b. $R_2 = 4.78 \times 10^{-5}$ Ω
c. $R_2 = 2.39 \times 10^{-5}$ Ω