

Name: Solutions

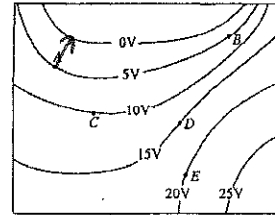
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Quiz name: Physics 2 - Electric Potential and Circuits

The diagram above shows equipotential lines produced by an unknown charge distribution. A, B, C, D, and E are points in the plane.

1. Which vector below best describes the direction of the electric field at point A?

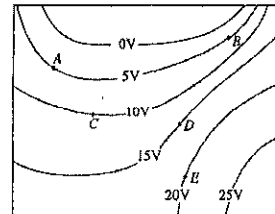
- A Up and Right
- B Down and Left
- C Down and Right
- D Up and Left



The diagram above shows equipotential lines produced by an unknown charge distribution. A, B, C, D, and E are points in the plane.

2. At which point does the electric field have the greatest magnitude?

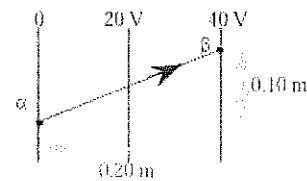
- A A
- B B
- C C
- D D
- E E



3. In the figure above, equipotential lines are drawn at 0, 20.0 V, and 40.0 V. The total work done in moving a point charge of + 3.00 mC from position a to position b is:

- A 4.00 mJ
- B 8.00 mJ
- C 12.0 mJ
- D 120 mJ

$$\Delta U = Q \Delta V = (3 \text{ mC})(40) = 120 \text{ mJ}$$



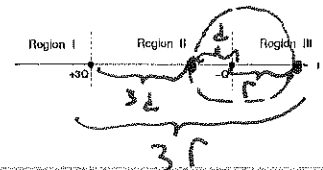
4. In which Region(s) is there a place on the x-axis (aside from infinity) at which the electric potential is equal to zero?

- A Only in Region II
- B In both Regions I and II
- C In both Regions I and III
- D In both Regions II and III

$$V_1 = k \frac{-3q}{3d} = -k \frac{q}{d} \quad V_E = V_1 + V_2 = 0$$

$$V_2 = k \frac{+q}{d} = k \frac{q}{d}$$

Same for the r 's

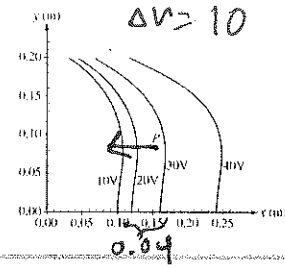


A fixed charge distribution produces the equipotential lines shown in the figure above.

5. Which of the following expressions best represents the magnitude of the electric field at point P?

- A 10 V/0.14 m
- B 10 V/0.04 m
- C 25 V/0.14 m
- D 25 V/0.04 m

$$E = \frac{\Delta V}{\Delta r} =$$

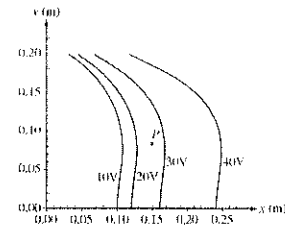


A fixed charge distribution produces the equipotential lines shown in the figure above.

6. The direction of the electric field at point P is most nearly

- A toward the left
- B toward the right
- C toward the bottom of the page
- D toward the top of the page

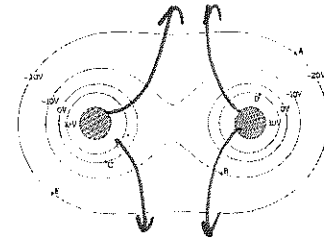
high to low potential



The diagram above shows some of the equipotentials in a plane perpendicular to two parallel charged metal cylinders. The potential of each line is labeled.

7. What charges are the cylinder?

- A Left: Positive Right: Positive
- B Left: Positive Right: Negative
- C Left: Negative Right: Positive
- D Left: Negative Right: Negative

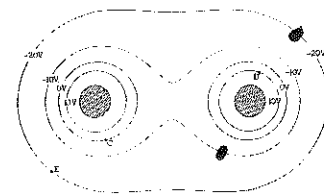


The diagram above shows some of the equipotentials in a plane perpendicular to two parallel charged metal cylinders. The potential of each line is labeled.

8. What is the potential difference going from point A to point B?

- A -10 V
- B -20 V
- C 20 V
- D 10 V

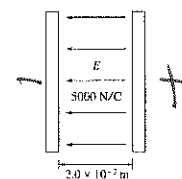
$$(-10) - (-20) = +10$$



Two parallel conducting plates, each of area 0.30 m^2 , are separated by a distance of $2.0 \times 10^{-2} \text{ m}$ of air. One plate has charge $+Q$; the other has charge $-Q$. An electric field of 5000 N/C is directed to the left in the space between the plates, as shown in the diagram above.

9. Indicate on the diagram which plate is positive (+) and which is negative (-).

- A Left: Positive Right: Negative
- B Left: Negative Right: Positive



Note: Figure not drawn to scale.

Two parallel conducting plates, each of area 0.30 m^2 , are separated by a distance of $2.0 \times 10^{-2} \text{ m}$ of air. One plate has charge $+Q$; the other has charge $-Q$. An electric field of 5000 N/C is directed to the left in the space between the plates, as shown in the diagram above.

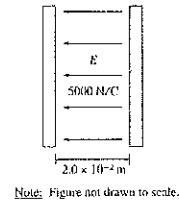
10. Determine the potential difference between the plates.

- (A) 250,000 V
- (B) 10,000 V
- (C) 100 V
- (D) 2,500

$$E = \frac{\Delta V}{d}$$

$$\Delta V = E \cdot d$$

$$= (5000)(0.02) = 100 \text{ V}$$



11. Two capacitors are connected in parallel as shown above. A voltage V is applied to the pair. What is the ratio of charge stored on C_1 to the charge stored on C_2 , when $C_1 = 1.5C_2$?

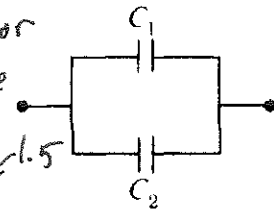
- (A) 2/3
- (B) 1
- (C) 3/2
- (D) 9/4

$$C = \frac{Q}{\Delta V}$$

$$Q = C \Delta V$$

ΔV is the same for both, since they are in parallel. So

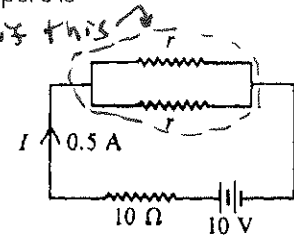
$$\frac{C_1}{C_2} = \frac{Q_1}{Q_2} = \left(\frac{3}{2}\right)$$



12. In the circuit shown above, the value of r for which the current I is 0.5 ampere is

- (A) 1Ω
- (B) 5Ω
- (C) 10Ω
- (D) 20Ω

Total R must be 20Ω . This will happen if this setup is 10Ω . This can only happen if each resistor is 20Ω .



13. The total capacitance of several capacitors in parallel is the sum of the individual capacitances for which of the following reasons?

- (A) The charge on each capacitor depends on its capacitance, but the potential difference across each is the same.
- (B) The charge is the same on each capacitor, but the potential difference across each capacitor depends on its capacitance.
- (C) Capacitors in a circuit always combine like resistors in series.
- (D) The parallel combination increases the effective separation of the plates.

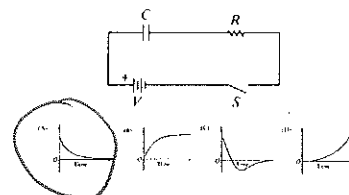
$$C_t = \frac{q_1 + q_2 + q_3}{V} = \frac{q_1}{V} + \frac{q_2}{V} + \dots$$

$$C_t = C_1 + C_2 + \dots$$

Assume the capacitor C is initially uncharged. The following graphs may represent different quantities related to the circuit as functions of time t after the switch S is closed

14. Which graph best represents the voltage versus time across the resistor R ?

- (A)
- (B)
- (C)
- (D)

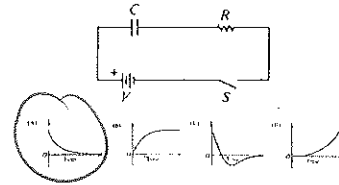


Assume the capacitor C is initially uncharged. The following graphs may represent different quantities related to the circuit as functions of time t after the switch S is closed

15. Which graph best represents the current versus time in the circuit?

- A
- B
- C
- D

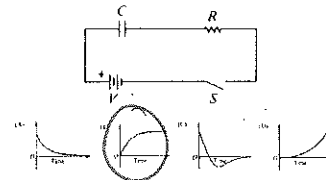
$\Delta V \propto I$



Assume the capacitor C is initially uncharged. The following graphs may represent different quantities related to the circuit as functions of time t after the switch S is closed

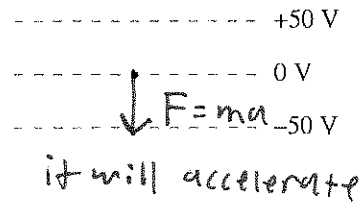
16. Which graph best represents the voltage across the capacitor versus time?

- A
- B
- C
- D



17. A proton is released from rest at the dot. Afterward, the proton

- A Remains at the dot
- B Moves upward with steady speed.
- C Moves upward with an increasing speed.
- D Moves downward with a steady speed.
- E Moves downward with an increasing speed.



18. If a positive charge is released from rest, it moves in the direction of

- A A stronger electric field.
- B A weaker electric field.
- C Higher electric potential.
- D Lower electric potential.
- E Both B and D.

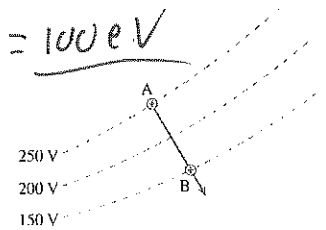
High to low Potential

A proton starts from rest at point A. It then accelerates past point B.

19. The proton's kinetic energy at Point B is

- A 250 eV
- B 200 eV
- C 150 eV
- D 100 eV

$\Delta U = q \Delta V = (1e)(100V) = 100 eV$



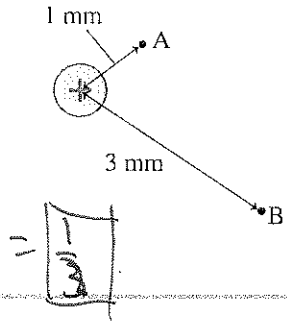
20. What is the ratio V_B/V_A of the electric potentials at the two points?

- (A) 9
- (B) 3
- (C) 1/3
- (D) 1/9
- (E) Undefined without knowing the charge

$$V_A = k \frac{q}{r} = \frac{1}{3} k \frac{q}{r}$$

$$V_B = k \frac{q}{3r} = \frac{1}{3} k \frac{q}{r}$$

$$\frac{V_B}{V_A} = \frac{\frac{1}{3} k \frac{q}{r}}{\frac{1}{3} k \frac{q}{r}} = 1$$



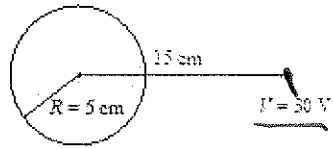
21. What is the electric potential at the surface of the sphere?

- (A) 15 V
- (B) 30 V
- (C) 60 V
- (D) 90 V
- (E) 120 V

"r" has been reduced to 1/3

so V will be tripled.

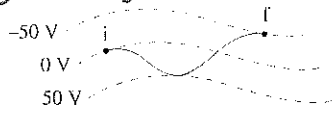
$$V \propto k \frac{q}{r} \rightarrow V \propto \frac{1}{r}$$



22. A particle follows the trajectory shown from initial position i to final position f. The potential difference V is

- (A) -100 V
- (B) -50 V
- (C) 0 V
- (D) 50 V
- (E) 100 V

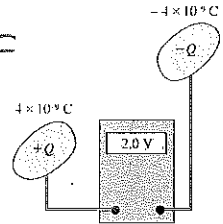
$$\Delta V = -50 - 0 = -50 \text{ V}$$



23. What is the capacitance of these two electrodes?

- (A) 8 nF
- (B) 4 nF
- (C) 2 nF
- (D) 1 nF
- (E) Some other value

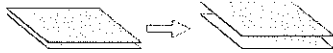
$$C = \frac{Q}{\Delta V} = \frac{4 \text{ nC}}{2 \text{ V}} = 2 \text{ nF}$$



A capacitor has a charge Q. The plates are then pulled apart so that the distance between them is larger.

24. After the plates are pulled apart,

- (A) The charge increases and the electric field decreases.
- (B) The charge decreases and the electric field increases.
- (C) Both the charge and the field increase.
- (D) Both the charge and the field decrease.
- (E) The charge and the field remain constant.



but ΔV increases.

25. A capacitor charged to 1.5 V stores 2.0 mJ of energy. If the capacitor is charged to 3.0 V, it will store

- (A) 1.0 mJ
- (B) 2.0 mJ
- (C) 4.0 mJ
- (D) 6.0 mJ

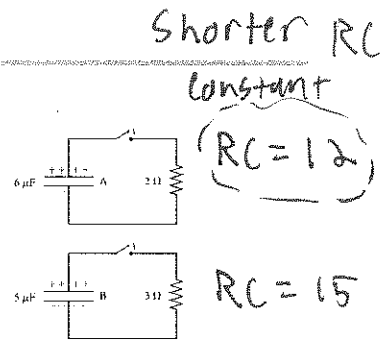
$$U = \frac{1}{2} CV^2 \leftarrow \text{"see" the } V^2? \text{ !!}$$

V doubled → U quadrupled.

8.0 mJ

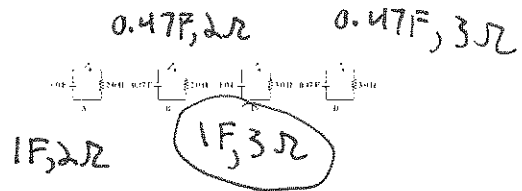
26. Which capacitor discharges more quickly after the switch is closed?

- (A) Capacitor A
- (B) Capacitor B
- (C) They discharge at the same rate.
- (D) We can't say without knowing the initial amount of charge.



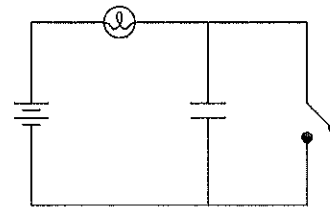
27. The following circuits contain capacitors that are charged to 5.0 V. All of the switches are closed at the same time. After 1 second has passed, which capacitor is charged to the highest voltage?

- (A) A
 - (B) B
 - (C) C
 - (D) D
- The one with the largest RC constant will discharge the slowest.



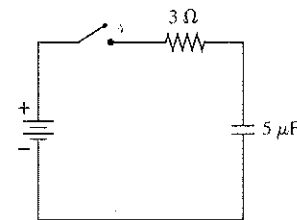
28. In the following circuit, the switch is initially closed and the bulb glows brightly. When the switch is opened, what happens to the brightness of the bulb?

- (A) The brightness of the bulb is not affected.
- (B) The bulb starts at the same brightness and then gradually dims.
- (C) The bulb starts at the same brightness and then gradually brightens.
- (D) The bulb initially brightens, then gradually dims.
- (E) The bulb initially dims, then gradually brightens.



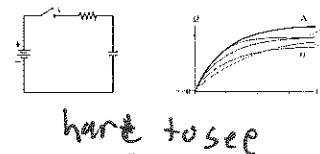
29. The capacitor is initially uncharged. Immediately after the switch closes, the capacitor voltage is

- (A) 0 V
 - (B) Somewhere between 0 V and 6 V
 - (C) 6 V
 - (D) Undefined.
- Still uncharged. has not had time to charge.



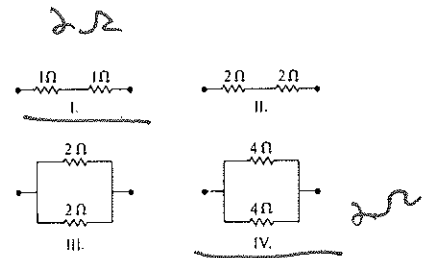
30. The red curve shows how the capacitor charges after the switch is closed at $t = 0$. Which curve shows the capacitor charging if the value of the resistor is reduced?

- (A) A
 - (B) B
 - (C) C
 - (D) D
- needs a smaller RC constant, meaning it charges quicker.



31. Multiple Correct. Which arrangements of resistors shown above have the same resistance between the terminals? Select two answers

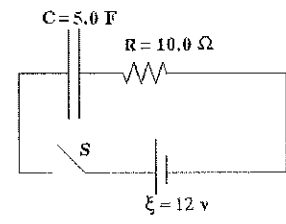
- I
- II
- III
- IV



For the RC circuit shown, the resistance is $R = 10.0 \Omega$, the capacitance is $C = 500.0 \mu\text{F}$ and the battery has voltage $\xi = 12$ volts. The capacitor is initially uncharged when the switch S is closed at time $t = 0$. At some time later, the current in the circuit is 0.50 A. What is the potential difference across the resistor at that time?

- A 5 Volts
- B 6 Volts
- C 7 Volts
- D 12 Volts
- E 0 Volts

$$\Delta V = IR = (0.5)(10) = 5 \text{ V}$$



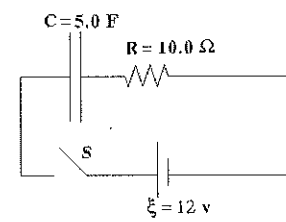
For the RC circuit shown, the resistance is $R = 10.0 \Omega$, the capacitance is $C = 500.0 \mu\text{F}$ and the battery has voltage $\xi = 12$ volts. The capacitor is initially uncharged when the switch S is closed at time $t = 0$. At some time later, the current in the circuit is 0.50 A. What is the potential difference across the Capacitor at that time?

- A 5 Volts
- B 6 Volts
- C 7 Volts
- D 12 Volts
- E 0 Volts

$$V_E = V_1 + V_2$$

$$12 \text{ V} = 5 \text{ V} + V_2$$

$$V_2 = 7 \text{ V}$$



A 9-volt battery is connected to four resistors to form a simple circuit as shown.

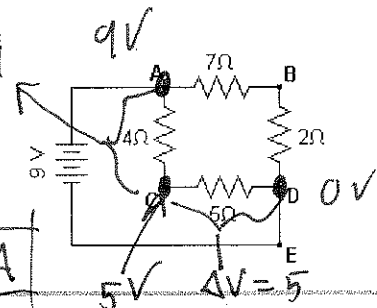
34. What would be the current at point E in the circuit?

- A 2 A
- B 4 A
- C 5 A
- D 7 A

$$R_t = \frac{1}{\frac{1}{9} + \frac{1}{9}} = \frac{2}{9}$$

$$R_t = \frac{9}{2} = 4.5$$

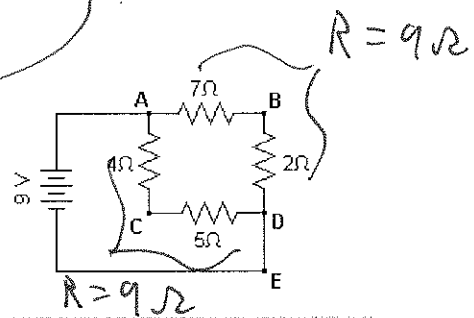
$$\Delta V = I_t R_t \quad I_t = \frac{9 \text{ V}}{4.5} = 2 \text{ A}$$



A 9-volt battery is connected to four resistors to form a simple circuit as shown

35. What would be the potential difference from point B to point D?

- A 2 V
- B 4 V
- C 5 V
- D 7 V

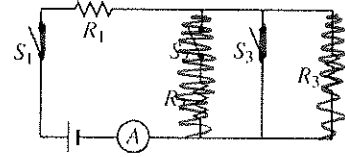


In the circuit above, the resistors all have the same resistance. The battery, wires, and ammeter have negligible resistance. A closed switch also has negligible resistance.

36. Closing which of the switches will produce the greatest reading on the ammeter?

- A S_1 only
- B S_2 only
- C S_1 and S_2
- D S_1 and S_3

Closing only S_1 & S_3
 Creates a circuit with only R_1 , hence the ~~smallest~~
 smallest resistance.



37. Capacitance is:

- A measure in farads
- B the ratio of the magnitude of the charge on either conductor of a capacitor to the magnitude of the potential difference between the conductors.
- C constant for a parallel plate capacitor
- D all three choices.

38. In a circuit, a capacitor has potential difference ΔV , charge Q , and capacitance C . The potential difference is doubled. The capacitance:

- A changes in ways impossible to predict with the given information
- B doubles.
- C does not change.
- D is divided in half

You can only change capacitance by increasing area or decreasing separation.

39. To increase the capacitance of a parallel-plate capacitor, you can:

- A increase the area of the plates.
- B increase the distance between the plates.
- C all of these choices.
- D none of these choices.

Either increase area or decrease distance.

40. A 330 pF capacitor and a 220 pF capacitor are each connected across a 6 V dc source. The voltage across the 330 pF capacitor is

- A 2 V
- B 3 V
- C 4 V
- D 6 V

Means parallel,
 hence the potential difference is the same.