Instructor: *Field/Korytov*

PHYSICS DEPARTMENT

PHY 2054 Exam 1 Sept. 30, 2015

Name (PRINT, last, first): ______________________ Signature: ______________________

On my honor, I have neither given nor received unauthorized aid on this examination.

YOUR TEST NUMBER IS THE 5-DIGIT NUMBER AT THE TOP OF EACH PAGE.

DIRECTIONS

(1) **Code your test number on your answer sheet (use 76–80 for the 5-digit number)**. Code your name on your answer sheet. **DARKEN CIRCLES COMPLETELY**. Code your student number on your answer sheet.
(2) Print your name on this sheet and sign it also.
(3) Do all scratch work anywhere on this exam that you like. At the end of the test, this exam printout is to be turned in. No credit will be given without both answer sheet and printout with scratch work most questions demand.
(4) **Blacken the circle of your intended answer completely, using a #2 pencil or blue or black ink**. Do not make any stray marks or the answer sheet may not read properly.
(5) The answers are rounded off. Choose the closest to exact. There is no penalty for guessing.

>>>>>>>>>**WHEN YOU FINISH** <<<<<<<<<
Hand in the answer sheet separately.

Constants			
$\epsilon_0 = 8.85 \times 10^{-12}$ F/m	$m_e = 9.11 \times 10^{-31}$ kg	$m_p = m_n = 1.67 \times 10^{-27}$ kg	$e = 1.6 \times 10^{-19}$ C
$k = 8.99 \times 10^9$ N m^2/C^2	$\mu_0 = 12.56 \times 10^{-7}$ H/m	$N_A = 6.02 \times 10^{23}$ atoms/mole	$c = 3 \times 10^8$ m/s
milli $= 10^{-3}$	micro $= 10^{-6}$	nano $= 10^{-9}$	pico $= 10^{-12}$

PHY2054 Exam 1 Formula Sheet

Vectors

$\vec{a} = a_x\hat{x} + a_y\hat{y} + a_z\hat{z}$ $\vec{b} = b_x\hat{x} + b_y\hat{y} + b_z\hat{z}$ **Magnitudes:** $|\vec{a}| = \sqrt{a_x^2 + a_y^2 + a_z^2}$ $|\vec{b}| = \sqrt{b_x^2 + b_y^2 + b_z^2}$

Scalar Product: $\vec{a}\cdot\vec{b} = a_x b_x + a_y b_y + a_z b_z = |\vec{a}||\vec{b}|\cos\theta$ (θ = angle between $\vec{a}$ and $\vec{b}$)

Electrostatic Force and Electric Field

Electrostatic Force (vector): $\vec{F} = k\dfrac{q_1 q_2}{r^2}\hat{r}$ (r = distance between charge q_1 and charge q_2, units = N)

$k = 1/(4\pi\varepsilon_0) = 8.99\times10^9\ \text{N}\cdot\text{m}^2/\text{C}^2$ $\varepsilon_0 = 8.85\times10^{-12}\ \text{C}^2/(\text{N}\cdot\text{m}^2)$

Electric Field (at q_2 due to q_1): $\vec{E} = \vec{F}/q_2 = k\dfrac{q_1}{r^2}\hat{r}$ (units = N/C = V/m)

Electric Flux (through the infinitesimal surface area dA)**:** $d\Phi_E = \vec{E}\cdot d\vec{A}$ (units = Nm²/C)

Vector Area (directed area): $\vec{A} = A\hat{n}$ (where $\hat{n}$ = normal to the surface)

Gauss' Law (net flux through closed surface **S**)**:** $\Phi_E = \oint_S \vec{E}\cdot d\vec{A} = \dfrac{Q_{enclosed}}{\varepsilon_0}$ ($Q_{enclosed}$ = charge enclosed)

Gauss' Law: Net flux through closed surface **S** = the charge enclosed by surface S divided by ε_0

Electric Potential and Potential Energy

Electric Potential Energy: work done against a constant field E in moving charge q a distance d along straight line path from A to B, $\Delta U = U_B - U_A = -q\vec{E}\cdot\vec{d}$ (units = J)

Electric Potential: Work done per unit charge against a constant field E in moving charge q a distance d along straight line path from A to B, $\Delta V = \Delta U/q = -\vec{E}\cdot\vec{d}$ (units = J/C = V)

Electric Potential (distance r from a point charge q)**:** $V(r) = k\dfrac{q}{r}$ N point charges: $V(r) = \sum_{i=1}^{N} k\dfrac{q_i}{r_i}$

Electric Potential Energy (N point charges): $U = \frac{1}{2}\sum_{i=1}^{N} q_i V_i$, where V_i is the electric potential at q_i due to the other charges

Stored Electric Potential Energy (N conductors with charge Q_i and electric potential V_i)**:** $U = \frac{1}{2}\sum_{i=1}^{N} Q_i V_i$

Capacitance (definition)**: C = Q/V** or **C = Q/ΔV** (units = C/V = F)

Energy Density of the Electric Field: $u = \frac{1}{2}\varepsilon_0 E^2$ (units = J/m³)

Electric Current and Circuits

Current (through directed area A)**:** $I = \dfrac{dQ}{dt} = \vec{J}\cdot\vec{A} = nq\vec{v}_{drift}\cdot\vec{A}$ (units = C/s = A, n is the number of charged particles q per unit volume, v_{drift} is the average velocity of the charged particles).

Conducting Wire (length L, cross sectional area A)**:** $J = \sigma E$, $I = \sigma EA = EA/\rho$, $|\Delta V| = EL$

Ohm's Law: $|\Delta V| = IR$, $R = \rho L/A$ (Resistance R units = V/A = Ω)

Resistivity (at temperature T in °C)**:** $\rho(T) = \rho_0(1 + \alpha\Delta T)$, where $\Delta T = T - T_0$

Power (supplied by EMF ε)**:** P = εI **Power** (dissipated in resistor R)**:** P = I²R (units = J/s = W)

RC Circuits (charging capacitor C through resistor R with EMF ε)**:** $Q(t) = \varepsilon C(1 - e^{-t/\tau})$

RC Circuits (discharging capacitor C with initial charge Q_0 through resistor R)**:** $Q(t) = Q_0 e^{-t/\tau}$

RC Circuits (time constant)**:** τ = RC (units = Ω·F = s)

1. Which of the following statements are true?
   (A) Unlike gravity, the electrostatic force can be both attractive and repulsive.
   (B) Electric field lines never cross.
   (C) Positively charged particles move from high to low electric potential.
   (D) The kinetic energy and the electric potential energy are always positive.
   (E) In static equilibrium the electric field is always zero inside and on the surface of a conductor.

   (1) All are true except D and E
   (2) All are true except D
   (3) All are true except E
   (4) All are true except B
   (5) All are false except A

2. Which of the following statements are true?
   (A) Unlike gravity, the electrostatic force can be both attractive and repulsive.
   (B) Electric field lines never cross.
   (C) The kinetic energy and the electric potential energy are always positive.
   (D) Positively charged particles move from high to low electric potential.
   (E) In static equilibrium the electric field is always zero inside and on the surface of a conductor.

   (1) All are true except C and E
   (2) All are true except C
   (3) All are true except E
   (4) All are true except B
   (5) All are false except A

3. . Which of the following statements are true?
   (A) Unlike gravity, the electrostatic force can be both attractive and repulsive.
   (B) Electric field lines never cross.
   (C) In static equilibrium the electric field is always zero inside and on the surface of a conductor.
   (D) The kinetic energy and the electric potential energy are always positive.
   (E) Positively charged particles move from high to low electric potential.

   (1) All are true except C and D
   (2) All are true except D
   (3) All are true except C
   (4) All are true except B
   (5) All are false except A

4. A 1 gram particle with a charge of 2 mC starts from rest in a uniform electric field. If the particle travels 20 meters in 2 seconds, what is the magnitude of the uniform electric field (in N/C)?

   (1) 5 (2) 10 (3) 15 (4) 2 (5) 20

5. A 1 gram particle with a charge of 2 mC starts from rest in a uniform electric field. If the particle travels 40 meters in 2 seconds, what is the magnitude of the uniform electric field (in N/C)?

   (1) 10 (2) 5 (3) 15 (4) 2 (5) 20

6. A 1 gram particle with a charge of 2 mC starts from rest in a uniform electric field. If the particle travels 60 meters in 2 seconds, what is the magnitude of the uniform electric field (in N/C)?

   (1) 15 (2) 5 (3) 10 (4) 2 (5) 20

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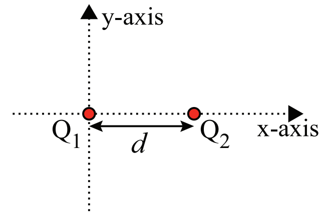
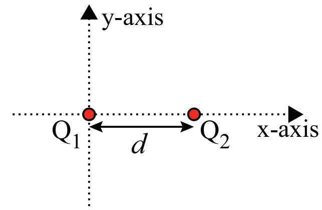
7. Two point charges, $Q_1 = 4Q$ and $Q_2 = -Q$, lie on the x-axis. The charge Q_1 is at the origin ($x = 0$) and the Q_2 charge is at $x = d$ as shown in the figure. At what point on the x-axis is the net electric field from these two charges equal to zero?



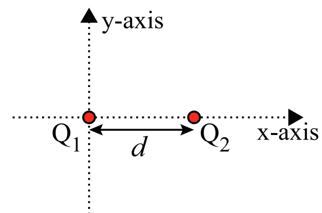
(1) $x = 2d$ (2) $x = 2d/3$ (3) $x = 3d/2$ (4) $x = 3d/4$ (5) $x = 3d$

8. Two point charges, $Q_1 = 4Q$ and $Q_2 = Q$, lie on the x-axis. The charge Q_1 is at the origin ($x = 0$) and the Q_2 charge is at $x = d$ as shown in the figure. At what point on the x-axis is the net electric field from these two charges equal to zero?



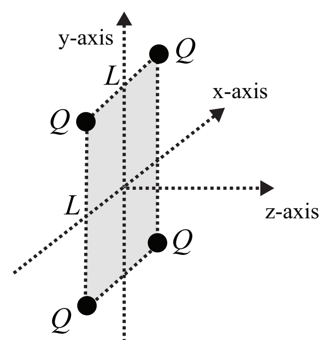
(1) $x = 2d/3$ (2) $x = 2d$ (3) $x = 3d/2$ (4) $x = 3d/4$ (5) $x = 3d$

9. Two point charges, $Q_1 = 9Q$ and $Q_2 = -Q$, lie on the x-axis. The charge Q_1 is at the origin ($x = 0$) and the Q_2 charge is at $x = d$ as shown in the figure. At what point on the x-axis is the net electric field from these two charges equal to zero?



(1) $x = 3d/2$ (2) $x = 2d$ (3) $x = 2d/3$ (4) $x = 3d/4$ (5) $x = 3d$

10. Four identical point charges $+Q$ are located at the corners of a square with sides of length L that lies in the xy-plane with its center at the origin as shown in the figure. What is the magnitude of the electric field on the z-axis a distance $z = L$ from the origin? Note: $k = 1/(4\pi\epsilon_0)$.

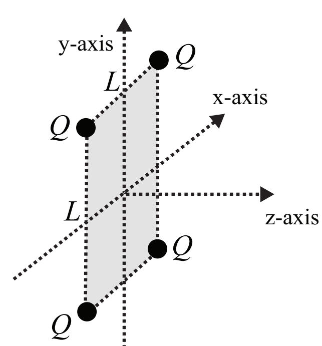


(1) $2.18kQ/L^2$
(2) $3.08kQ/L^2$
(3) $1.32kQ/L^2$
(4) $2.67kQ/L^2$
(5) $4kQ/L^2$

11. In the previous problem, what is the electric potential on the z-axis a distance $z = L$ from the origin? Note: $k = 1/(4\pi\epsilon_0)$.

(1) $3.27kQ/L$ (2) $4.62kQ/L$ (3) $2.41kQ/L$ (4) $1.89kQ/L$ (5) $4kQ/L$

12. Four identical point charges $+Q$ are located at the corners of a square with sides of length L that lies in the xy-plane with its center at the origin as shown in the figure. What is the magnitude of the electric field on the z-axis a distance $z = L/2$ from the origin? Note: $k = 1/(4\pi\epsilon_0)$.

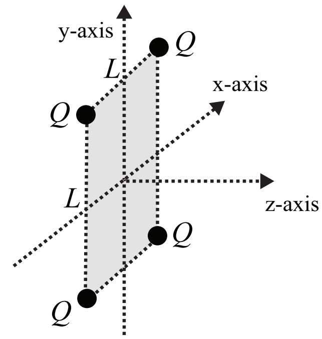


(1) $3.08kQ/L^2$
(2) $2.18kQ/L^2$
(3) $1.32kQ/L^2$
(4) $5.33kQ/L^2$
(5) $4kQ/L^2$

13. In the previous problem, what is the electric potential on the z-axis a distance $z = L/2$ from the origin? Note: $k = 1/(4\pi\epsilon_0)$.

(1) $4.62kQ/L$ (2) $3.27kQ/L$ (3) $2.41kQ/L$ (4) $1.89kQ/L$ (5) $4kQ/L$

14. Four identical point charges $+Q$ are located at the corners of a square with sides of length L that lies in the xy-plane with its center at the origin as shown in the figure. What is the magnitude of the electric field on the z-axis a distance $z = 3L/2$ from the origin? Note: $k = 1/(4\pi\epsilon_0)$.



(1) $1.32kQ/L^2$
(2) $2.18kQ/L^2$
(3) $3.08kQ/L^2$
(4) $1.45kQ/L^2$
(5) $4kQ/L^2$

15. In the previous problem, what is the electric potential on the z-axis a distance $z = 2L/3$ from the origin? Note: $k = 1/(4\pi\epsilon_0)$.

(1) $2.41kQ/L$ (2) $3.27kQ/L$ (3) $4.62kQ/L$ (4) $1.89kQ/L$ (5) $4kQ/L$

16. The electric field at the surface of solid spherical conductor with a radius of 2 meters points radially away from the conductor and has a magnitude of 899 N/C. What is the net charge on the conductor (in μC)?

(1) 0.4 (2) 0.9 (3) 1.6 (4) 0.2 (5) 2.0

17. How much electric energy (in μJ) is stored by the solid spherical conductor in the previous problem?

(1) 360 (2) 1,214 (3) 2,877 (4) 160 (5) 3,899

18. The electric field at the surface of solid spherical conductor with a radius of 3 meters points radially away from the conductor and has a magnitude of 899 N/C. What is the net charge on the conductor (in μC)?

(1) 0.9 (2) 0.4 (3) 1.6 (4) 0.2 (5) 2.0

19. How much electric energy (in μJ) is stored by the solid spherical conductor in the previous problem?

(1) 1,214 (2) 360 (3) 2,877 (4) 160 (5) 3,899

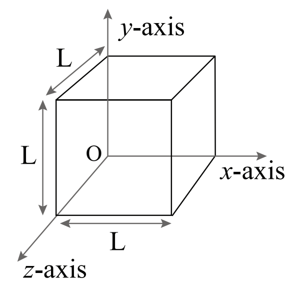
20. The electric field at the surface of solid spherical conductor with a radius of 4 meters points radially away from the conductor and has a magnitude of 899 N/C. What is the net charge on the conductor (in μC)?

(1) 1.6 (2) 0.4 (3) 0.9 (4) 0.2 (5) 2.0

21. How much electric energy (in μJ) is stored by the solid spherical conductor in the previous problem?

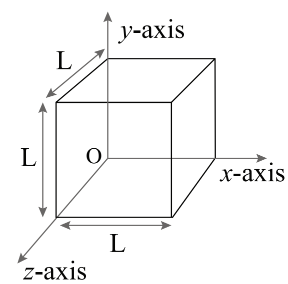
(1) 2,877 (2) 360 (3) 1,214 (4) 160 (5) 3,899

22. Consider a cube of sides $L = 2$ m as shown in the figure and suppose that a non-uniform electric field is present and is given by $\vec{E}(x) = ax\,\hat{x}$, where $a = 100$ V/m^2 is a constant. The electric field points along the x-axis and has a magnitude given by $E(x) = ax$. What is the net electric charge (in nanoC) contained within the cube?



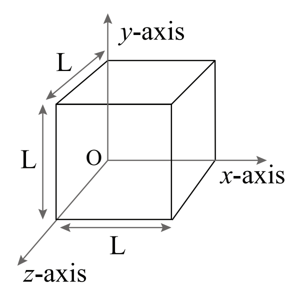
(1) 7.08 (2) 23.90 (3) 56.65 (4) 4.58 (5) zero

23. Consider a cube of sides $L = 3$ m as shown in the figure and suppose that a non-uniform electric field is present and is given by $\vec{E}(x) = ax\,\hat{x}$, where $a = 100$ V/m^2 is a constant. The electric field points along the x-axis and has a magnitude given by $E(x) = ax$. What is the net electric charge (in nanoC) contained within the cube?



(1) 23.90 (2) 7.08 (3) 56.65 (4) 4.58 (5) zero

24. Consider a cube of sides $L = 4$ m as shown in the figure and suppose that a non-uniform electric field is present and is given by $\vec{E}(x) = ax\,\hat{x}$, where $a = 100$ V/m^2 is a constant. The electric field points along the x-axis and has a magnitude given by $E(x) = ax$. What is the net electric charge (in nanoC) contained within the cube?



(1) 56.65 (2) 7.08 (3) 23.90 (4) 4.58 (5) zero

25. If the energy density of a uniform electric field is $2\,\mu$J/m^3, what is the magnitude of the electric field (in V/m)?

(1) 672.2 (2) 823.3 (3) 950.7 (4) 475.3 (5) 1,265.2

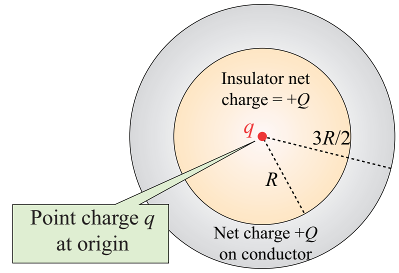
26. If the energy density of a uniform electric field is $3\,\mu$J/m^3, what is the magnitude of the electric field (in V/m)?

(1) 823.3 (2) 672.2 (3) 950.7 (4) 475.3 (5) 1,265.2

27. If the energy density of a uniform electric field is $4\,\mu$J/m^3, what is the magnitude of the electric field (in V/m)?

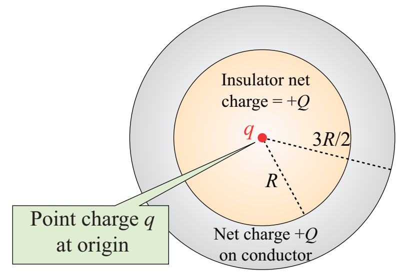
(1) 950.7 (2) 672.2 (3) 823.3 (4) 475.3 (5) 1,265.2

28. A solid insulating ball with radius R has a uniform charge density ρ and total charge $+Q$. There is a point charge $q = -2Q$ embedded at the center of the insulator (not part of the insulator). The insulating ball is surrounded by a spherical conducting shell with inner radius R and outer radius $3R/2$ as shown in the figure. The net charge on the conductor is $+Q$. How much charge is located on the outer surface ($r = 3R/2$) of the conductor?



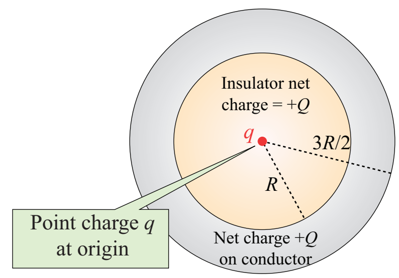
(1) zero (2) $-Q$ (3) $-2Q$ (4) Q (5) $2Q$

29. A solid insulating ball with radius R has a uniform charge density ρ and total charge $+Q$. There is a point charge $q = -3Q$ embedded at the center of the insulator (not part of the insulator). The insulating ball is surrounded by a spherical conducting shell with inner radius R and outer radius $3R/2$ as shown in the figure. The net charge on the conductor is $+Q$. How much charge is located on the outer surface ($r = 3R/2$) of the conductor?



(1) $-Q$ (2) zero (3) $-2Q$ (4) Q (5) $2Q$

30. A solid insulating ball with radius R has a uniform charge density ρ and total charge $+Q$. There is a point charge $q = -4Q$ embedded at the center of the insulator (not part of the insulator). The insulating ball is surrounded by a spherical conducting shell with inner radius R and outer radius $3R/2$ as shown in the figure. The net charge on the conductor is $+Q$. How much charge is located on the outer surface ($r = 3R/2$) of the conductor?



(1) $-2Q$ (2) zero (3) $-Q$ (4) Q (5) $2Q$

31. The resistance of a certain resistor varies linearly with temperature. If its resistance is $1\,\Omega$ at 10°C and $5\,\Omega$ at 50°C, what is its resistance at 20°C?

(1) $2\,\Omega$ (2) $3\,\Omega$ (3) $4\,\Omega$ (4) $2.5\,\Omega$ (5) $3.5\,\Omega$

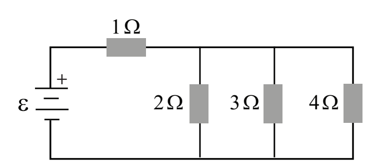
32. The resistance of a certain resistor varies linearly with temperature. If its resistance is $1\,\Omega$ at 10°C and $5\,\Omega$ at 50°C, what is its resistance at 30°C?

(1) $3\,\Omega$ (2) $2\,\Omega$ (3) $4\,\Omega$ (4) $2.5\,\Omega$ (5) $3.5\,\Omega$

33. The resistance of a certain resistor varies linearly with temperature. If its resistance is $1\,\Omega$ at 10°C and $5\,\Omega$ at 50°C, what is its resistance at 40°C?

(1) $4\,\Omega$ (2) $2\,\Omega$ (3) $3\,\Omega$ (4) $2.5\,\Omega$ (5) $3.5\,\Omega$

34. Consider the circuit consisting of an EMF and four resistors shown in the figure. If the EMF $\epsilon = 25$ V, how much current flows through the $1\,\Omega$ resistor (in Amps)?



(1) 13 (2) 26 (3) 39 (4) 5 (5) 46

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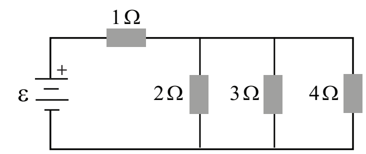
35. In the previous problem, what is the magnitude of the potential difference across the $2\,\Omega$ resistor (in Volts)?

(1) 12 (2) 24 (3) 36 (4) 6 (5) 48

36. Consider the circuit consisting of an EMF and four resistors shown in the figure. If the EMF $\epsilon = 50$ V, how much current flows through the $1\,\Omega$ resistor (in Amps)?

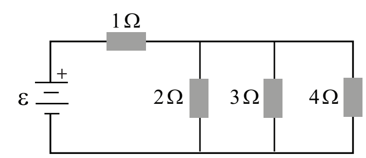


(1) 26 (2) 13 (3) 39 (4) 5 (5) 46

37. In the previous problem, what is the magnitude of the potential difference across the $2\,\Omega$ resistor (in Volts)?

(1) 24 (2) 12 (3) 36 (4) 6 (5) 48

38. Consider the circuit consisting of an EMF and four resistors shown in the figure. If the EMF $\epsilon = 75$ V, how much current flows through the $1\,\Omega$ resistor (in Amps)?

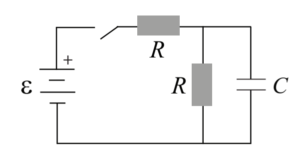


(1) 39 (2) 13 (3) 26 (4) 5 (5) 46

39. In the previous problem, what is the magnitude of the potential difference across the $2\,\Omega$ resistor (in Volts)?

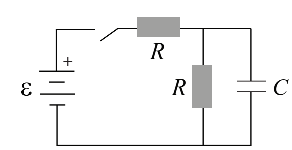
(1) 36 (2) 12 (3) 24 (4) 6 (5) 48

40. Consider the charging of a capacitor with a 10 V EMF as shown in the figure. The capacitor has capacitance $C = 0.2$ F and no initial charge. Both resistors have resistance $R = 2\,\Omega$ and the switch is closed at $t = 0$. What is the current through the EMF (in Amps) immediately after the switch is closed?



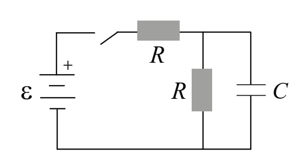
(1) 5 (2) 10 (3) 15 (4) 2.5 (5) 7.5

41. Consider the charging of a capacitor with a 20 V EMF as shown in the figure. The capacitor has capacitance $C = 0.2$ F and no initial charge. Both resistors have resistance $R = 2\,\Omega$ and the switch is closed at $t = 0$. What is the current through the EMF (in Amps) immediately after the switch is closed?



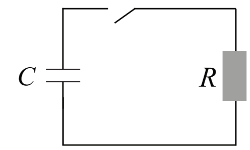
(1) 10 (2) 5 (3) 15 (4) 2.5 (5) 7.5

42. Consider the charging of a capacitor with a 30 V EMF as shown in the figure. The capacitor has capacitance $C = 0.2$ F and no initial charge. Both resistors have resistance $R = 2\,\Omega$ and the switch is closed at $t = 0$. What is the current through the EMF (in Amps) immediately after the switch is closed?



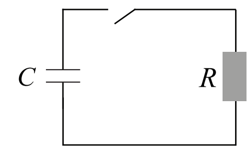
(1) 15 (2) 5 (3) 10 (4) 2.5 (5) 7.5

43. Consider the discharging of a capacitor through a single resistor with $R = 0.2\,\Omega$ as shown in the figure. The capacitor has capacitance an initial charge Q_0 and the switch is closed at $t = 0$. If the charge on the capacitor is $Q_0/2$ at $t = 1\,\mu$s, what is its capacitance C (in microF)?



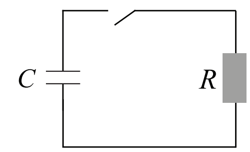
(1) 7.21 (2) 3.61 (3) 2.40 (4) 8.78 (5) 1.75

44. Consider the discharging of a capacitor through a single resistor with $R = 0.4\,\Omega$ as shown in the figure. The capacitor has capacitance an initial charge Q_0 and the switch is closed at $t = 0$. If the charge on the capacitor is $Q_0/2$ at $t = 1\,\mu$s, what is its capacitance C (in microF)?



(1) 3.61 (2) 7.21 (3) 2.40 (4) 8.78 (5) 1.75

45. Consider the discharging of a capacitor through a single resistor with $R = 0.6\,\Omega$ as shown in the figure. The capacitor has capacitance an initial charge Q_0 and the switch is closed at $t = 0$. If the charge on the capacitor is $Q_0/2$ at $t = 1\,\mu$s, what is its capacitance C (in microF)?



(1) 2.40 (2) 7.21 (3) 3.61 (4) 8.78 (5) 1.75

46. A high voltage transmission line of diameter 2.0 cm and length 200 km carries a steady current of 1000 Amps. If the conductor is copper with a free charge density of 16×10^{28} electrons/m^3, how long does it take (in years) for one electron to travel the full length of the cable? (Note: $e = 1.6 \times 10^{-19}$C and use 1 year = 365 days.)

(1) 51 (2) 29 (3) 13 (4) 6 (5) 65

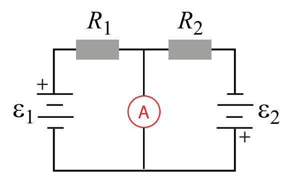
47. A high voltage transmission line of diameter 1.5 cm and length 200 km carries a steady current of 1000 Amps. If the conductor is copper with a free charge density of 16×10^{28} electrons/m^3, how long does it take (in years) for one electron to travel the full length of the cable? (Note: $e = 1.6 \times 10^{-19}$C and use 1 year = 365 days.)

(1) 29 (2) 51 (3) 13 (4) 6 (5) 65

48. A high voltage transmission line of diameter 1.0 cm and length 200 km carries a steady current of 1000 Amps. If the conductor is copper with a free charge density of 16×10^{28} electrons/m^3, how long does it take (in years) for one electron to travel the full length of the cable? (Note: $e = 1.6 \times 10^{-19}$C and use 1 year = 365 days.)

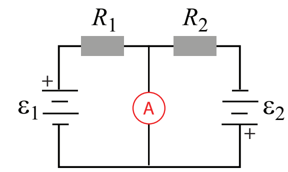
(1) 13 (2) 51 (3) 29 (4) 6 (5) 65

49. An ammeter is a device with negligible resistance that measures current flow. Consider the circuit shown in the figure consisting of two EMF's, two resistors, and an ammeter. If the ammeter reads zero current when $R_1 = 2R_2$ and $\epsilon_1 = 12$ Volts, what is ϵ_2 (in Volts)?



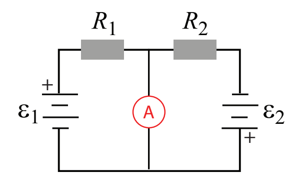
(1) 6 (2) 24 (3) 4 (4) 36 (5) 12

50. An ammeter is a device with negligible resistance that measures current flow. Consider the circuit shown in the figure consisting of two EMF's, two resistors, and an ammeter. If the ammeter reads zero current when $R_1 = R_2/2$ and $\epsilon_1 = 12$ Volts, what is ϵ_2 (in Volts)?



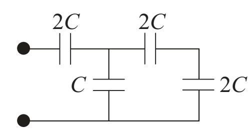
(1) 24 (2) 6 (3) 4 (4) 36 (5) 12

51. An ammeter is a device with negligible resistance that measures current flow. Consider the circuit shown in the figure consisting of two EMF's, two resistors, and an ammeter. If the ammeter reads zero current when $R_1 = 3R_2$ and $\epsilon_1 = 12$ Volts, what is ϵ_2 (in Volts)?



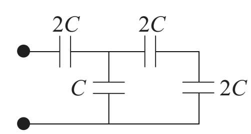
(1) 4 (2) 6 (3) 24 (4) 36 (5) 12

52. If $C = 20\,\mu$F, what is the equivalent capacitance for the combination of four capacitors shown in the figure (in μF)?



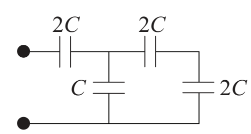
(1) 20 (2) 40 (3) 60 (4) 80 (5) 10

53. If $C = 40\,\mu$F, what is the equivalent capacitance for the combination of four capacitors shown in the figure (in μF)?



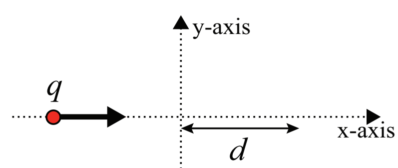
(1) 40 (2) 20 (3) 60 (4) 80 (5) 10

54. If $C = 60\,\mu$F, what is the equivalent capacitance for the combination of four capacitors shown in the figure (in μF)?



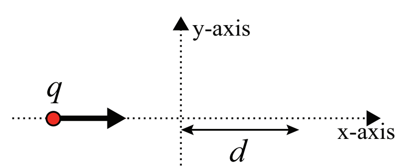
(1) 60 (2) 20 (3) 40 (4) 80 (5) 10

55. A charged particle q traveling to the right along the negative x-axis as shown in the figure has an initial kinetic energy of $24\,\mu$J. At $x = 0$ it experiences a non-uniform electric potential given by $V(x) = bx^2$, where $b = 6$ V/m^2 is a constant and x is measured in meters. If $q = 4\,\mu$C, what is the largest positive x-value (in meters) reached by the particle before it comes to rest?



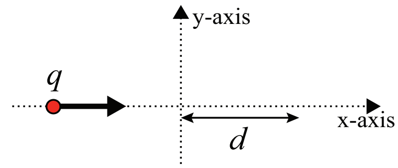
(1) 1 (2) 2 (3) 3 (4) 4 (5) 9

56. A charged particle q traveling to the right along the negative x-axis as shown in the figure has an initial kinetic energy of $96\,\mu$J. At $x = 0$ it experiences a non-uniform electric potential given by $V(x) = bx^2$, where $b = 6$ V/m^2 is a constant and x is measured in meters. If $q = 4\,\mu$C, what is the largest positive x-value (in meters) reached by the particle before it comes to rest?



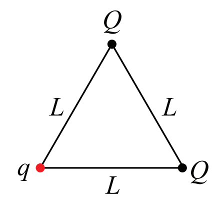
(1) 2 (2) 1 (3) 3 (4) 4 (5) 9

57. A charged particle q traveling to the right along the negative x-axis as shown in the figure has an initial kinetic energy of $216\,\mu$J. At $x = 0$ it experiences a non-uniform electric potential given by $V(x) = bx^2$, where $b = 6$ V/m^2 is a constant and x is measured in meters. If $q = 4\,\mu$C, what is the largest positive x- value (in meters) reached by the particle before it comes to rest?



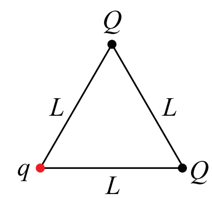
(1) 3 (2) 1 (3) 2 (4) 4 (5) 9

58. Three point charges $Q_1 = q$, $Q_2 = Q$, and $Q_3 = Q$ are fixed at the vertices of an equilateral triangle with sides of length L as shown in the figure. If $q = 2Q$, how much work is required to move charge q to the center of the triangle? Note the center is equal distance from the three vertices and $k = 1/(4\pi\epsilon_0)$.



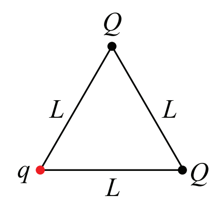
(1) $2.93kQ^2/L$ (2) $4.39kQ^2/L$ (3) $5.86kQ^2/L$ (4) $1.46kQ^2/L$ (5) $2.20kQ^2/L$

59. Three point charges $Q_1 = q$, $Q_2 = Q$, and $Q_3 = Q$ are fixed at the vertices of an equilateral triangle with sides of length L as shown in the figure. If $q = 3Q$, how much work is required to move charge q to the center of the triangle? Note the center is equal distance from the three vertices and $k = 1/(4\pi\epsilon_0)$.



(1) $4.39kQ^2/L$ (2) $2.93kQ^2/L$ (3) $5.86kQ^2/L$ (4) $1.46kQ^2/L$ (5) $2.20kQ^2/L$

60. Three point charges $Q_1 = q$, $Q_2 = Q$, and $Q_3 = Q$ are fixed at the vertices of an equilateral triangle with sides of length L as shown in the figure. If $q = 4Q$, how much work is required to move charge q to the center of the triangle? Note the center is equal distance from the three vertices and $k = 1/(4\pi\epsilon_0)$.



(1) $5.86kQ^2/L$ (2) $2.93kQ^2/L$ (3) $4.39kQ^2/L$ (4) $1.46kQ^2/L$ (5) $2.20kQ^2/L$

THE FOLLOWING QUESTIONS, NUMBERED IN THE ORDER OF THEIR APPEARANCE ON THE ABOVE LIST, HAVE BEEN FLAGGED AS CONTINUATION QUESTIONS: 11 13 15 17 19 21 35 37 39 FOLLOWING GROUPS OF QUESTIONS WILL BE SELECTED AS ONE GROUP FROM EACH TYPE

TYPE 1
Q# S 1
Q# S 2
Q# S 3
TYPE 2
Q# S 4
Q# S 5
Q# S 6
TYPE 3
Q# S 7
Q# S 8
Q# S 9
TYPE 4
Q# S 10 11
Q# S 12 13
Q# S 14 15
TYPE 5
Q# S 16 17
Q# S 18 19
Q# S 20 21

TYPE 6
Q# S 22
Q# S 23
Q# S 24
TYPE 7
Q# S 25
Q# S 26
Q# S 27
TYPE 8
Q# S 28
Q# S 29
Q# S 30
TYPE 9
Q# S 31
Q# S 32
Q# S 33
TYPE 10
Q# S 34 35
Q# S 36 37
Q# S 38 39
TYPE 11
Q# S 40
Q# S 41
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TYPE 12
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TYPE 13
Q# S 46
Q# S 47
Q# S 48
TYPE 14
Q# S 49
Q# S 50
Q# S 51
TYPE 15
Q# S 52
Q# S 53
Q# S 54
TYPE 16
Q# S 55
Q# S 56
Q# S 57
TYPE 17
Q# S 58
Q# S 59
Q# S 60