

AP Physics C: Electricity and Magnetism Practice Test 12

60 original multiple-choice questions covering all 6 AP Physics C: Electricity and Magnetism units (Units 8–13). All questions are calculus-based. Choose one answer for each question. The full answer key is on the last page — worked explanations for every question are free on the test page at QuaidianPoint.com.

Name: _____ Class: _____ Score: _____ / 60

Unit 8: Electric Charges, Fields, and Gauss's Law

Q1. Two small point charges of $5\ \mu\text{C}$ and $4\ \mu\text{C}$ are held $0.2\ \text{m}$ apart in a vacuum. What is the magnitude of the electrostatic force exerted on either charge?

- (A) $9\ \text{N}$
- (B) $2.25\ \text{N}$
- (C) $18\ \text{N}$
- (D) $4.5\ \text{N}$

Q2. A point charge of $2\ \mu\text{C}$ is fixed in a vacuum. What is the magnitude of the electric field at a point $0.5\ \text{m}$ from the charge?

- (A) $1.44 \times 10^5\ \text{N/C}$
- (B) $3.60 \times 10^4\ \text{N/C}$
- (C) $7.20 \times 10^4\ \text{N/C}$
- (D) $7.20 \times 10^5\ \text{N/C}$

Q3. Two point charges, $+2\ \mu\text{C}$ and $+6\ \mu\text{C}$, are fixed $0.6\ \text{m}$ apart. What is the magnitude of the net electric field at the midpoint between them?

- (A) $8.00 \times 10^5\ \text{N/C}$
- (B) $4.00 \times 10^5\ \text{N/C}$
- (C) $2.00 \times 10^5\ \text{N/C}$
- (D) $1.20 \times 10^6\ \text{N/C}$

Q4. A closed Gaussian surface encloses a net charge of $6\ \mu\text{C}$ and no other charge. What is the net electric flux through the surface?

- (A) $1.36 \times 10^6\ \text{N}\cdot\text{m}^2/\text{C}$
- (B) $3.39 \times 10^5\ \text{N}\cdot\text{m}^2/\text{C}$
- (C) $6.78 \times 10^6\ \text{N}\cdot\text{m}^2/\text{C}$
- (D) $6.78 \times 10^5\ \text{N}\cdot\text{m}^2/\text{C}$

Q5. A solid insulating sphere of radius $0.15\ \text{m}$ carries a total charge of $12\ \mu\text{C}$ uniformly distributed through its volume. What is the magnitude of the electric field at a distance $0.25\ \text{m}$ from the centre of the sphere?

- (A) $3.46 \times 10^6\ \text{N/C}$
- (B) $8.64 \times 10^5\ \text{N/C}$
- (C) $1.73 \times 10^6\ \text{N/C}$
- (D) $6.91 \times 10^6\ \text{N/C}$

Q6. A solid insulating sphere of radius 0.2 m carries a total charge of $8\ \mu\text{C}$ uniformly distributed through its volume. What is the magnitude of the electric field inside the sphere at a distance 0.1 m from its centre?

- (A) $1.80 \times 10^6\ \text{N/C}$
- (B) $9.00 \times 10^5\ \text{N/C}$
- (C) $4.50 \times 10^5\ \text{N/C}$
- (D) $3.60 \times 10^6\ \text{N/C}$

Q7. An infinitely long straight line of charge has a uniform linear charge density of $10\ \text{nC/m}$. What is the magnitude of the electric field at a perpendicular distance of 0.5 m from the line?

- (A) 720 N/C
- (B) 180 N/C
- (C) 1440 N/C
- (D) 360 N/C

Q8. An infinite nonconducting sheet carries a uniform surface charge density of $4\ \mu\text{C/m}^2$. What is the magnitude of the electric field near the sheet, on either side of it?

- (A) 452 kN/C
- (B) 226 kN/C
- (C) 113 kN/C
- (D) 904 kN/C

Q9. A thin ring of radius 0.2 m carries a total charge of $8\ \mu\text{C}$ uniformly distributed around it. What is the magnitude of the electric field on the axis of the ring at a distance of 0.4 m from its centre?

- (A) $6.44 \times 10^5\ \text{N/C}$
- (B) $3.22 \times 10^5\ \text{N/C}$
- (C) $1.61 \times 10^5\ \text{N/C}$
- (D) $3.22 \times 10^6\ \text{N/C}$

Q10. A uniform electric field of 400 N/C passes through a flat surface of area $0.05\ \text{m}^2$. The angle between the field and the normal to the surface is 0° . What is the electric flux through the surface?

- (A) $40\ \text{N}\cdot\text{m}^2/\text{C}$
- (B) $20\ \text{N}\cdot\text{m}^2/\text{C}$
- (C) $10\ \text{N}\cdot\text{m}^2/\text{C}$
- (D) $80\ \text{N}\cdot\text{m}^2/\text{C}$

Q11. The electric field at the surface of a uniformly charged spherical shell has magnitude 4000 N/C, directed radially outward, and the shell has radius 0.1 m. What is the total charge on the shell?

- (A) $8.89 \times 10^{-3}\ \mu\text{C}$
- (B) $4.44 \times 10^{-3}\ \mu\text{C}$
- (C) $2.22 \times 10^{-3}\ \mu\text{C}$
- (D) $0.0178\ \mu\text{C}$

Q12. A thin rod of length 0.45 m carries a uniform linear charge density λ . A point P lies on the axis of the rod at a distance 0.1 m from its nearer end. Which integral gives the magnitude of the electric field at P?

- (A) $\int_0^{0.45} k\lambda \, dx / (0.1 + x)^2$
- (B) $\int_0^{0.45} k\lambda \, dx / (0.1 + x)$
- (C) $\int_0^{0.45} k\lambda x \, dx / (0.1 + x)^2$
- (D) $k\lambda 0.45 / (0.1)^2$

Unit 9: Electric Potential

Q13. A point charge of 4 μC is fixed in a vacuum. Taking the potential at infinity to be zero, what is the electric potential at a distance 0.4 m from the charge?

- (A) 90 kV
- (B) 180 kV
- (C) 45 kV
- (D) 360 kV

Q14. A charge of 3 μC is moved slowly from a point at potential 0 V to a point at potential 2000 V by an external agent. How much work is done by the external agent?

- (A) 12 mJ
- (B) 3 mJ
- (C) 6 mJ
- (D) 24 mJ

Q15. Two point charges of 2 μC and 3 μC are 0.3 m apart. What is the electric potential energy of this pair, taking zero energy at infinite separation?

- (A) 180 mJ
- (B) 360 mJ
- (C) 90 mJ
- (D) 720 mJ

Q16. A thin ring of radius 0.2 m carries a total charge of 8 μC uniformly distributed around it. What is the electric potential on the axis of the ring at a distance of 0.5 m from its centre, with zero potential at infinity?

- (A) 134 kV
- (B) 267 kV
- (C) 66.9 kV
- (D) 535 kV

Q17. A thin rod of length 0.45 m carries a uniform linear charge density λ . A point P lies on the axis of the rod at a distance 0.2 m from its nearer end. Which integral gives the electric potential at P, with zero potential at infinity?

- (A) $\int_0^{0.45} k\lambda \, dx / (0.2 + x)$
- (B) $\int_0^{0.45} k\lambda \, dx / (0.2 + x)^2$
- (C) $\int_0^{0.45} k\lambda x \, dx / (0.2 + x)$
- (D) $k\lambda 0.45 / (0.2)$

Q18. In a region, the electric potential varies with position as $V(x) = 5x^2 + 4x + 5$, where V is in volts and x is in metres. What is the x -component of the electric field at $x = 3$ m?

- (A) -68 V/m
- (B) -17 V/m
- (C) 34 V/m
- (D) -34 V/m

Q19. A conducting spherical shell of radius 0.25 m carries a total charge of $6\ \mu\text{C}$. What is the electric potential at a point inside the shell, 0.05 m from its centre, with zero potential at infinity?

- (A) 216 kV
- (B) 432 kV
- (C) 108 kV
- (D) 864 kV

Q20. A particle of charge $4\ \mu\text{C}$ is released from rest at a point where the potential is 1000 V higher than at a second point. If no non-electric forces act, what kinetic energy does it gain in moving to the second point?

- (A) 8 mJ
- (B) 4 mJ
- (C) 2 mJ
- (D) 16 mJ

Q21. An electric dipole consists of charges $+4\ \mu\text{C}$ and $-4\ \mu\text{C}$ separated by 0.04 m. Estimate the electric potential on the dipole axis at a distance 0.4 m from its centre, with zero potential at infinity, using the far-field dipole approximation.

- (A) 18 kV
- (B) 4.5 kV
- (C) 36 kV
- (D) 9 kV

Unit 10: Conductors and Capacitors

Q22. A parallel-plate capacitor has plates of area $0.04\ \text{m}^2$ separated by 1 mm in a vacuum. What is its capacitance?

- (A) 708 pF
- (B) 354 pF
- (C) 177 pF
- (D) 1420 pF

Q23. A parallel-plate capacitor has capacitance 100 pF in air. A dielectric slab of dielectric constant 5 is inserted to fill the space between the plates completely, with the plates isolated so charge stays fixed. What is the new capacitance?

- (A) 500 pF
- (B) 1000 pF
- (C) 250 pF
- (D) 2000 pF

Q24. Capacitors of $20\ \mu\text{F}$ and $20\ \mu\text{F}$ are connected in series. What is their equivalent capacitance?

- (A) $20\ \mu\text{F}$
- (B) $5\ \mu\text{F}$
- (C) $10\ \mu\text{F}$
- (D) $30\ \mu\text{F}$

Q25. A capacitor of $5\ \mu\text{F}$ is charged to a potential difference of $200\ \text{V}$. How much energy is stored in it?

- (A) $200\ \text{mJ}$
- (B) $100\ \text{mJ}$
- (C) $50\ \text{mJ}$
- (D) $400\ \text{mJ}$

Q26. A capacitor of $5\ \mu\text{F}$ is connected across a $100\ \text{V}$ battery until fully charged. What charge is stored on either plate?

- (A) $500\ \mu\text{C}$
- (B) $1000\ \mu\text{C}$
- (C) $250\ \mu\text{C}$
- (D) $2000\ \mu\text{C}$

Q27. A spherical capacitor consists of concentric conducting spheres of radii $0.1\ \text{m}$ and $0.2\ \text{m}$, with vacuum between them. What is its capacitance?

- (A) $22.2\ \text{pF}$
- (B) $44.5\ \text{pF}$
- (C) $11.1\ \text{pF}$
- (D) $89\ \text{pF}$

Q28. An irregularly shaped solid conductor is given a net charge and allowed to reach electrostatic equilibrium. Which statement is correct?

- (A) Excess charge is spread uniformly through the volume, and the field inside is uniform.
- (B) Excess charge resides on the outer surface with uniform density, and the field inside is nonzero near sharp points.
- (C) Excess charge resides at the centre, and the field inside is zero only at the centre.
- (D) Excess charge resides on the outer surface, the field inside is zero, and surface charge density is greatest where the surface curves most sharply.

Q29. The electric field between the plates of a capacitor is $40000\ \text{N/C}$. What is the energy density stored in the field?

- (A) $14.2\ \text{mJ/m}^3$
- (B) $7.08\ \text{mJ/m}^3$
- (C) $3.54\ \text{mJ/m}^3$
- (D) $28.3\ \text{mJ/m}^3$

Unit 11: Electric Circuits

- Q30.** A wire of length 4 m and cross-sectional area 2 mm^2 is made of a material of resistivity $2.8 \times 10^{-8} \Omega \cdot \text{m}$. What is the resistance of the wire?
- (A) 0.112Ω
 - (B) 0.028Ω
 - (C) 0.056Ω
 - (D) 0.224Ω
- Q31.** Resistors of 4Ω and 4Ω are connected in parallel. What is their equivalent resistance?
- (A) 4Ω
 - (B) 1Ω
 - (C) 2Ω
 - (D) 6Ω
- Q32.** A 36 V battery with negligible internal resistance is connected across a 12Ω resistor. What current flows through the resistor?
- (A) 6 A
 - (B) 3 A
 - (C) 1.5 A
 - (D) 12 A
- Q33.** In a single loop, two batteries of emfs 18 V and 8 V oppose each other, and the total resistance in the loop is 6Ω . What is the current in the loop, in the direction of the larger emf?
- (A) 3.33 A
 - (B) 0.833 A
 - (C) 1.67 A
 - (D) 6.67 A
- Q34.** A current of 3 A flows through a 20Ω resistor. At what rate is energy dissipated as heat in the resistor?
- (A) 360 W
 - (B) 90 W
 - (C) 180 W
 - (D) 720 W
- Q35.** A capacitor of $50 \mu\text{F}$ is connected in series with a $50 \text{ k}\Omega$ resistor. What is the time constant of this RC circuit?
- (A) 5 s
 - (B) 1.25 s
 - (C) 2.5 s
 - (D) 10 s
- Q36.** A capacitor in an RC circuit charges toward a maximum charge of $40 \mu\text{C}$. After a time equal to 1 time constant(s), what charge is on the capacitor?
- (A) $50.6 \mu\text{C}$
 - (B) $12.6 \mu\text{C}$
 - (C) $25.3 \mu\text{C}$
 - (D) $101 \mu\text{C}$

Q37. A discharging RC circuit has an initial current of 30 mA. After a time equal to 1 time constant(s), what is the current?

- (A) 11 mA
- (B) 22.1 mA
- (C) 5.52 mA
- (D) 44.1 mA

Q38. An RC circuit with time constant 1 s is charging from zero charge. How long does it take for the charge to reach 75% of its maximum value?

- (A) 2.77 s
- (B) 0.693 s
- (C) 5.54 s
- (D) 1.39 s

Q39. A battery of emf 24 V and internal resistance 1 Ω delivers a current of 1 A to an external circuit. What is the terminal potential difference of the battery?

- (A) 23 V
- (B) 46 V
- (C) 11.5 V
- (D) 92 V

Q40. Resistors of 4 Ω and 8 Ω are connected in parallel across a 24 V battery. What is the current through the 4 Ω resistor?

- (A) 12 A
- (B) 3 A
- (C) 24 A
- (D) 6 A

Q41. In a series circuit, a 24 V battery is connected to a 4 Ω resistor in series with a 12 Ω resistor, and a capacitor is connected in parallel with the 12 Ω resistor. In steady state, what is the potential difference across the capacitor?

- (A) 36 V
- (B) 9 V
- (C) 72 V
- (D) 18 V

Unit 12: Magnetic Fields and Electromagnetism

Q42. A particle of charge 2 μC moves at 3×10^4 m/s perpendicular to a uniform magnetic field of 0.2 T. What is the magnitude of the magnetic force on the particle?

- (A) 24 mN
- (B) 6 mN
- (C) 48 mN
- (D) 12 mN

Q43. An alpha particle (mass 6.4×10^{-27} kg, charge 3.2×10^{-19} C) moves at 6×10^6 m/s perpendicular to a uniform magnetic field of 0.25 T. What is the radius of its circular path?

- (A) 96 cm
- (B) 24 cm
- (C) 48 cm
- (D) 192 cm

Q44. A straight wire of length 1 m carries a current of 5 A perpendicular to a uniform magnetic field of 50 mT. What is the magnitude of the magnetic force on the wire?

- (A) 500 mN
- (B) 125 mN
- (C) 1000 mN
- (D) 250 mN

Q45. A long straight wire carries a current of 4 A. What is the magnitude of the magnetic field at a distance of 20 cm from the wire?

- (A) 4 μ T
- (B) 8 μ T
- (C) 2 μ T
- (D) 16 μ T

Q46. A circular loop of radius 20 cm carries a current of 5 A. What is the magnitude of the magnetic field at the centre of the loop?

- (A) 31.4 μ T
- (B) 7.85 μ T
- (C) 62.8 μ T
- (D) 15.7 μ T

Q47. A long solenoid has 500 turns per metre and carries a current of 2 A. What is the magnitude of the magnetic field inside the solenoid, far from its ends?

- (A) 2.51 mT
- (B) 0.628 mT
- (C) 5.03 mT
- (D) 1.26 mT

Q48. Two long parallel wires 10 cm apart carry currents of 2 A and 4 A in opposite directions. What is the magnitude of the net magnetic field at the midpoint between the wires?

- (A) 48 μ T
- (B) 24 μ T
- (C) 12 μ T
- (D) 96 μ T

Q49. A rectangular coil of 50 turns and area 0.02 m^2 carries a current of 3 A in a uniform magnetic field of 0.2 T. When the plane of the coil is parallel to the field, what is the magnitude of the torque on the coil?

- (A) 1200 mN·m
- (B) 600 mN·m
- (C) 300 mN·m
- (D) 2400 mN·m

Q50. In a velocity selector, a charged particle passes undeflected through crossed electric and magnetic fields of 2000 N/C and 20 mT. What is the speed of the particle?

- (A) 2.00×10^5 m/s
- (B) 1.00×10^5 m/s
- (C) 5.00×10^4 m/s
- (D) 4.00×10^5 m/s

Unit 13: Electromagnetic Induction

Q51. A flat loop of area 0.05 m^2 is placed in a uniform magnetic field of 200 mT. The angle between the field and the normal to the loop is 0° . What is the magnetic flux through the loop?

- (A) 20 mWb
- (B) 10 mWb
- (C) 5 mWb
- (D) 40 mWb

Q52. The magnetic field through a single loop of area 0.05 m^2 increases uniformly by 0.2 T in 0.1 s, with the field perpendicular to the loop. What is the magnitude of the induced emf in the loop?

- (A) 200 mV
- (B) 50 mV
- (C) 100 mV
- (D) 400 mV

Q53. A conducting rod of length 0.5 m moves at 2 m/s perpendicular to a uniform magnetic field of 0.4 T, with the rod perpendicular to both its velocity and the field. What is the motional emf between the ends of the rod?

- (A) 0.4 V
- (B) 0.8 V
- (C) 0.2 V
- (D) 1.6 V

Q54. A bar magnet with its north pole facing a conducting loop is pulled away from the loop. As seen from the magnet side, in which direction does the induced current flow in the loop, and why?

- (A) Counterclockwise, because the induced field must point away from the magnet to oppose the decreasing flux.
- (B) Clockwise, because the induced field must point toward the magnet to increase the flux loss.
- (C) Counterclockwise, because the induced current always reverses the direction of the magnet's motion.
- (D) Clockwise, because the induced field must point away from the magnet to oppose the decreasing flux.

Q55. A solenoid has 400 turns, a cross-sectional area of 20 cm^2 , and a length of 0.4 m. What is its self-inductance?

- (A) 2.01 mH
- (B) 0.503 mH
- (C) 4.02 mH
- (D) 1.01 mH

Q56. An inductor of 20 mH is connected in series with a 5Ω resistor. What is the time constant of this LR circuit?

- (A) 4 ms
- (B) 8 ms
- (C) 2 ms
- (D) 16 ms

Q57. A series LR circuit with battery voltage 24 V and resistance 12Ω is switched on at $t = 0$. After a time equal to 1 time constant(s), what is the current in the circuit?

- (A) 2.53 A
- (B) 0.632 A
- (C) 1.26 A
- (D) 5.06 A

Q58. An LC circuit consists of an inductor of 20 mH and a capacitor of $10 \mu\text{F}$. What is its natural frequency of oscillation?

- (A) 712 Hz
- (B) 178 Hz
- (C) 356 Hz
- (D) 1420 Hz

Q59. In an ideal LC circuit, a capacitor of $40 \mu\text{F}$ is initially charged to 20 V and then connected to an inductor of 20 mH. What is the maximum current in the circuit?

- (A) 1.79 A
- (B) 0.447 A
- (C) 0.894 A
- (D) 3.58 A

Q60. A coil of 10 turns and area 0.05 m^2 rotates in a uniform magnetic field of 0.1 T with angular speed 10 rad/s. What is the maximum induced emf in the coil?

- (A) 0.5 V
- (B) 1 V
- (C) 0.25 V
- (D) 2 V

Answer Key

Q1: D	Q11: B	Q21: D	Q31: C	Q41: D	Q51: B
Q2: C	Q12: A	Q22: B	Q32: B	Q42: D	Q52: C
Q3: B	Q13: A	Q23: A	Q33: C	Q43: C	Q53: A
Q4: D	Q14: C	Q24: C	Q34: C	Q44: D	Q54: D

Q5: C	Q15: A	Q25: B	Q35: C	Q45: A	Q55: D
Q6: B	Q16: A	Q26: A	Q36: C	Q46: D	Q56: A
Q7: D	Q17: A	Q27: A	Q37: A	Q47: D	Q57: C
Q8: B	Q18: D	Q28: D	Q38: D	Q48: B	Q58: C
Q9: B	Q19: A	Q29: B	Q39: A	Q49: B	Q59: C
Q10: B	Q20: B	Q30: C	Q40: D	Q50: B	Q60: A

Worked explanations for all 60 questions:

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