

AP Physics C: Electricity and Magnetism Practice Test 15

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 $2\ \mu\text{C}$ and $9\ \mu\text{C}$ are held $0.2\ \text{m}$ apart in a vacuum. What is the magnitude of the electrostatic force exerted on either charge?

- (A) $8.1\ \text{N}$
- (B) $2.02\ \text{N}$
- (C) $16.2\ \text{N}$
- (D) $4.05\ \text{N}$

Q2. A point charge of $8\ \mu\text{C}$ is fixed in a vacuum. What is the magnitude of the electric field at a point $0.4\ \text{m}$ from the charge?

- (A) $4.50 \times 10^5\ \text{N/C}$
- (B) $9.00 \times 10^5\ \text{N/C}$
- (C) $2.25 \times 10^5\ \text{N/C}$
- (D) $4.50 \times 10^6\ \text{N/C}$

Q3. Two point charges, $+6\ \mu\text{C}$ and $+2\ \mu\text{C}$, 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 $3\ \mu\text{C}$ and no other charge. What is the net electric flux through the surface?

- (A) $6.78 \times 10^5\ \text{N}\cdot\text{m}^2/\text{C}$
- (B) $1.69 \times 10^5\ \text{N}\cdot\text{m}^2/\text{C}$
- (C) $3.39 \times 10^6\ \text{N}\cdot\text{m}^2/\text{C}$
- (D) $3.39 \times 10^5\ \text{N}\cdot\text{m}^2/\text{C}$

Q5. A solid insulating sphere of radius $0.1\ \text{m}$ carries a total charge of $8\ \mu\text{C}$ uniformly distributed through its volume. What is the magnitude of the electric field at a distance $0.3\ \text{m}$ from the centre of the sphere?

- (A) $1.60 \times 10^6\ \text{N/C}$
- (B) $4.00 \times 10^5\ \text{N/C}$
- (C) $8.00 \times 10^5\ \text{N/C}$
- (D) $3.20 \times 10^6\ \text{N/C}$

Q6. A solid insulating sphere of radius 0.2 m carries a total charge of 12 μC 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) $2.70 \times 10^6 \text{ N/C}$
- (B) $6.75 \times 10^5 \text{ N/C}$
- (C) $1.35 \times 10^6 \text{ N/C}$
- (D) $5.40 \times 10^6 \text{ N/C}$

Q7. An infinitely long straight line of charge has a uniform linear charge density of 12 nC/m. What is the magnitude of the electric field at a perpendicular distance of 0.5 m from the line?

- (A) 864 N/C
- (B) 432 N/C
- (C) 216 N/C
- (D) 1730 N/C

Q8. An infinite nonconducting sheet carries a uniform surface charge density of 1 $\mu\text{C/m}^2$. What is the magnitude of the electric field near the sheet, on either side of it?

- (A) 113 kN/C
- (B) 28.2 kN/C
- (C) 226 kN/C
- (D) 56.5 kN/C

Q9. A thin ring of radius 0.3 m carries a total charge of 4 μC uniformly distributed around it. What is the magnitude of the electric field on the axis of the ring at a distance of 0.5 m from its centre?

- (A) $1.82 \times 10^5 \text{ N/C}$
- (B) $4.54 \times 10^4 \text{ N/C}$
- (C) $9.08 \times 10^5 \text{ N/C}$
- (D) $9.08 \times 10^4 \text{ N/C}$

Q10. A uniform electric field of 400 N/C passes through a flat surface of area 0.03 m^2 . The angle between the field and the normal to the surface is 60° . What is the electric flux through the surface?

- (A) $6 \text{ N}\cdot\text{m}^2/\text{C}$
- (B) $12 \text{ N}\cdot\text{m}^2/\text{C}$
- (C) $3 \text{ N}\cdot\text{m}^2/\text{C}$
- (D) $24 \text{ N}\cdot\text{m}^2/\text{C}$

Q11. The electric field at the surface of a uniformly charged spherical shell has magnitude 2000 N/C, directed radially outward, and the shell has radius 0.2 m. What is the total charge on the shell?

- (A) $8.89 \times 10^{-3} \mu\text{C}$
- (B) $0.0178 \mu\text{C}$
- (C) $4.44 \times 10^{-3} \mu\text{C}$
- (D) $0.0356 \mu\text{C}$

Q12. A thin rod of length 0.6 m carries a uniform linear charge density λ . A point P lies on the axis of the rod at a distance 0.15 m from its nearer end. Which integral gives the magnitude of the electric field at P?

- (A) $\int_0^{0.6} k\lambda \, dx / (0.15 + x)$
- (B) $\int_0^{0.6} k\lambda x \, dx / (0.15 + x)^2$
- (C) $k\lambda 0.6 / (0.15)^2$
- (D) $\int_0^{0.6} k\lambda \, dx / (0.15 + x)^2$

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 0.3 m from the charge?

- (A) 240 kV
- (B) 60 kV
- (C) 480 kV
- (D) 120 kV

Q14. A charge of 2 μC is moved slowly from a point at potential 0 V to a point at potential 3000 V by an external agent. How much work is done by the external agent?

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

Q15. Two point charges of 5 μC and 4 μC are 0.3 m apart. What is the electric potential energy of this pair, taking zero energy at infinite separation?

- (A) 1200 mJ
- (B) 300 mJ
- (C) 2400 mJ
- (D) 600 mJ

Q16. A thin ring of radius 0.4 m carries a total charge of 6 μC uniformly distributed around it. What is the electric potential on the axis of the ring at a distance of 0.3 m from its centre, with zero potential at infinity?

- (A) 216 kV
- (B) 108 kV
- (C) 54 kV
- (D) 432 kV

Q17. A thin rod of length 0.4 m carries a uniform linear charge density λ . A point P lies on the axis of the rod at a distance 0.25 m from its nearer end. Which integral gives the electric potential at P, with zero potential at infinity?

- (A) $\int_0^{0.4} k\lambda \, dx / (0.25 + x)^2$
- (B) $\int_0^{0.4} k\lambda x \, dx / (0.25 + x)$
- (C) $\int_0^{0.4} k\lambda \, dx / (0.25 + x)$
- (D) $k\lambda 0.4 / (0.25)$

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

- (A) -44 V/m
- (B) -11 V/m
- (C) -22 V/m
- (D) 22 V/m

Q19. A conducting spherical shell of radius 0.2 m carries a total charge of $4\text{ }\mu\text{C}$. What is the electric potential at a point inside the shell, 0.05 m from its centre, with zero potential at infinity?

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

Q20. A particle of charge $5\text{ }\mu\text{C}$ is released from rest at a point where the potential is 3000 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) 30 mJ
- (B) 7.5 mJ
- (C) 15 mJ
- (D) 60 mJ

Q21. An electric dipole consists of charges $+4\text{ }\mu\text{C}$ and $-4\text{ }\mu\text{C}$ separated by 0.02 m. Estimate the electric potential on the dipole axis at a distance 0.2 m from its centre, with zero potential at infinity, using the far-field dipole approximation.

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

Unit 10: Conductors and Capacitors

Q22. A parallel-plate capacitor has plates of area 0.01 m^2 separated by 4 mm in a vacuum. What is its capacitance?

- (A) 22.1 pF
- (B) 44.2 pF
- (C) 11.1 pF
- (D) 88.5 pF

Q23. A parallel-plate capacitor has capacitance 100 pF in air. A dielectric slab of dielectric constant 2 is inserted to fill the space between the plates completely, with the plates isolated so charge stays fixed. What is the new capacitance?

- (A) 400 pF
- (B) 200 pF
- (C) 100 pF
- (D) 800 pF

Q24. Capacitors of $10\ \mu\text{F}$ and $10\ \mu\text{F}$ are connected in series. What is their equivalent capacitance?

- (A) $10\ \mu\text{F}$
- (B) $5\ \mu\text{F}$
- (C) $2.5\ \mu\text{F}$
- (D) $15\ \mu\text{F}$

Q25. A capacitor of $5\ \mu\text{F}$ is charged to a potential difference of $100\ \text{V}$. How much energy is stored in it?

- (A) $25\ \text{mJ}$
- (B) $50\ \text{mJ}$
- (C) $12.5\ \text{mJ}$
- (D) $100\ \text{mJ}$

Q26. A capacitor of $4\ \mu\text{F}$ is connected across a $200\ \text{V}$ battery until fully charged. What charge is stored on either plate?

- (A) $1600\ \mu\text{C}$
- (B) $400\ \mu\text{C}$
- (C) $800\ \mu\text{C}$
- (D) $3200\ \mu\text{C}$

Q27. A spherical capacitor consists of concentric conducting spheres of radii $0.08\ \text{m}$ and $0.2\ \text{m}$, with vacuum between them. What is its capacitance?

- (A) $29.7\ \text{pF}$
- (B) $7.41\ \text{pF}$
- (C) $14.8\ \text{pF}$
- (D) $59.3\ \text{pF}$

Q28. A solid conducting sphere is given a net negative charge and allowed to reach electrostatic equilibrium. Which statement is correct?

- (A) All excess charge resides on the outer surface, and the electric field inside the sphere is zero.
- (B) Excess charge is spread uniformly through the volume, and the field inside is zero everywhere outside too.
- (C) All excess charge resides at the centre, and the field just outside is zero.
- (D) Excess charge resides on the outer surface, and the field inside points toward the centre with constant magnitude.

Q29. The electric field between the plates of a capacitor is $20000\ \text{N/C}$. What is the energy density stored in the field?

- (A) $3.54\ \text{mJ/m}^3$
- (B) $0.885\ \text{mJ/m}^3$
- (C) $1.77\ \text{mJ/m}^3$
- (D) $7.08\ \text{mJ/m}^3$

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 $5.0 \times 10^{-8} \Omega \cdot \text{m}$. What is the resistance of the wire?
- (A) 0.2Ω
 - (B) 0.1Ω
 - (C) 0.05Ω
 - (D) 0.4Ω
- Q31.** Resistors of 18Ω and 6Ω are connected in parallel. What is their equivalent resistance?
- (A) 9Ω
 - (B) 2.25Ω
 - (C) 13.5Ω
 - (D) 4.5Ω
- Q32.** A 36 V battery with negligible internal resistance is connected across a 4Ω resistor. What current flows through the resistor?
- (A) 18 A
 - (B) 4.5 A
 - (C) 9 A
 - (D) 36 A
- Q33.** In a single loop, two batteries of emfs 12 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) 0.667 A
 - (B) 1.33 A
 - (C) 0.333 A
 - (D) 2.67 A
- Q34.** A current of 4 A flows through a 20Ω resistor. At what rate is energy dissipated as heat in the resistor?
- (A) 640 W
 - (B) 160 W
 - (C) 1280 W
 - (D) 320 W
- Q35.** A capacitor of $20 \mu\text{F}$ is connected in series with a $20 \text{ k}\Omega$ resistor. What is the time constant of this RC circuit?
- (A) 0.8 s
 - (B) 0.2 s
 - (C) 1.6 s
 - (D) 0.4 s
- Q36.** A capacitor in an RC circuit charges toward a maximum charge of $60 \mu\text{C}$. After a time equal to 1 time constant(s), what charge is on the capacitor?
- (A) $37.9 \mu\text{C}$
 - (B) $75.9 \mu\text{C}$
 - (C) $19 \mu\text{C}$
 - (D) $152 \mu\text{C}$

Q37. A discharging RC circuit has an initial current of 20 mA. After a time equal to 1 time constant(s), what is the current?

- (A) 7.36 mA
- (B) 14.7 mA
- (C) 3.68 mA
- (D) 29.4 mA

Q38. An RC circuit with time constant 0.5 s is charging from zero charge. How long does it take for the charge to reach 50% of its maximum value?

- (A) 0.693 s
- (B) 0.173 s
- (C) 1.39 s
- (D) 0.346 s

Q39. A battery of emf 12 V and internal resistance $2\ \Omega$ delivers a current of 2 A to an external circuit. What is the terminal potential difference of the battery?

- (A) 16 V
- (B) 8 V
- (C) 4 V
- (D) 32 V

Q40. Resistors of $4\ \Omega$ and $12\ \Omega$ are connected in parallel across a 24 V battery. What is the current through the $4\ \Omega$ resistor?

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

Q41. In a series circuit, a 12 V battery is connected to a $6\ \Omega$ resistor in series with a $12\ \Omega$ resistor, and a capacitor is connected in parallel with the $12\ \Omega$ resistor. In steady state, what is the potential difference across the capacitor?

- (A) 16 V
- (B) 8 V
- (C) 4 V
- (D) 32 V

Unit 12: Magnetic Fields and Electromagnetism

Q42. A particle of charge $2\ \mu\text{C}$ moves at $2 \times 10^4\ \text{m/s}$ perpendicular to a uniform magnetic field of 0.2 T. What is the magnitude of the magnetic force on the particle?

- (A) 16 mN
- (B) 4 mN
- (C) 8 mN
- (D) 32 mN

Q43. An alpha particle (mass 6.4×10^{-27} kg, charge 3.2×10^{-19} C) moves at 2×10^6 m/s perpendicular to a uniform magnetic field of 0.5 T. What is the radius of its circular path?

- (A) 16 cm
- (B) 4 cm
- (C) 8 cm
- (D) 32 cm

Q44. A straight wire of length 0.5 m carries a current of 4 A perpendicular to a uniform magnetic field of 20 mT. What is the magnitude of the magnetic force on the wire?

- (A) 80 mN
- (B) 40 mN
- (C) 20 mN
- (D) 160 mN

Q45. A long straight wire carries a current of 5 A. What is the magnitude of the magnetic field at a distance of 20 cm from the wire?

- (A) $10 \mu\text{T}$
- (B) $5 \mu\text{T}$
- (C) $2.5 \mu\text{T}$
- (D) $20 \mu\text{T}$

Q46. A circular loop of radius 10 cm carries a current of 5 A. What is the magnitude of the magnetic field at the centre of the loop?

- (A) $62.8 \mu\text{T}$
- (B) $15.7 \mu\text{T}$
- (C) $126 \mu\text{T}$
- (D) $31.4 \mu\text{T}$

Q47. A long solenoid has 1000 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) 5.03 mT
- (C) 1.26 mT
- (D) 10.1 mT

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

- (A) $32 \mu\text{T}$
- (B) $8 \mu\text{T}$
- (C) $64 \mu\text{T}$
- (D) $16 \mu\text{T}$

Q49. A rectangular coil of 20 turns and area 0.04 m^2 carries a current of 2 A in a uniform magnetic field of 0.1 T. When the plane of the coil is parallel to the field, what is the magnitude of the torque on the coil?

- (A) 320 mN·m
- (B) 80 mN·m
- (C) 640 mN·m
- (D) 160 mN·m

Q50. In a velocity selector, a charged particle passes undeflected through crossed electric and magnetic fields of 4000 N/C and 40 mT. What is the speed of the particle?

- (A) 1.00×10^5 m/s
- (B) 2.00×10^5 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 0.04 m^2 is placed in a uniform magnetic field of 100 mT. The angle between the field and the normal to the loop is 60° . What is the magnetic flux through the loop?

- (A) 4 mWb
- (B) 2 mWb
- (C) 1 mWb
- (D) 8 mWb

Q52. The magnetic field through a single loop of area 0.02 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) 80 mV
- (B) 20 mV
- (C) 40 mV
- (D) 160 mV

Q53. A conducting rod of length 0.5 m moves at 4 m/s perpendicular to a uniform magnetic field of 0.5 T, with the rod perpendicular to both its velocity and the field. What is the motional emf between the ends of the rod?

- (A) 2 V
- (B) 0.5 V
- (C) 1 V
- (D) 4 V

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

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

Q55. A solenoid has 200 turns, a cross-sectional area of 10 cm^2 , and a length of 0.2 m. What is its self-inductance?

- (A) 0.251 mH
- (B) 0.503 mH
- (C) 0.126 mH
- (D) 1.01 mH

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

- (A) 2 ms
- (B) 1 ms
- (C) 0.5 ms
- (D) 4 ms

Q57. A series LR circuit with battery voltage 12 V and resistance 6Ω is switched on at $t = 0$. After a time equal to 1 time constant(s), what is the current in the circuit?

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

Q58. An LC circuit consists of an inductor of 10 mH and a capacitor of $25 \mu\text{F}$. What is its natural frequency of oscillation?

- (A) 318 Hz
- (B) 637 Hz
- (C) 159 Hz
- (D) 1270 Hz

Q59. In an ideal LC circuit, a capacitor of $40 \mu\text{F}$ is initially charged to 10 V and then connected to an inductor of 20 mH. What is the maximum current in the circuit?

- (A) 0.894 A
- (B) 0.224 A
- (C) 0.447 A
- (D) 1.79 A

Q60. A coil of 20 turns and area 0.04 m^2 rotates in a uniform magnetic field of 0.1 T with angular speed 50 rad/s. What is the maximum induced emf in the coil?

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

Answer Key

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

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

Worked explanations for all 60 questions:

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