Electricity and Magnetism Equations

$k = 9 \times 10^9$ N m^2/C^2 = $1/(4\pi\varepsilon_o)$

$\varepsilon_o = 8.85 \times 10^{-12}$ F/m [C^2/N/m^2]

$\mu_o = 4\pi \times 10^{-7}$ T m/A

$c = 3 \times 10^8$ m/s = speed of light in vacuum

1eV = 1.602×10^{-19} Joules

$h = 6.626 \times 10^{-34}$ J s = Planck's Constant

Electron

$q = -e = -1.602 \times 10^{-19}$ C

$m = m_e = 9.11 \times 10^{-31}$ kg

Proton

$q = +e = +1.602 \times 10^{-19}$ C

$m = m_p = 1.67 \times 10^{-27}$ kg

For point charges

1. $\vec{F} = k\frac{q_1 q_2}{r^2}\hat{r}$
2. $\vec{E} = k\frac{q}{r^2}\hat{r}$
3. $F = qE$ = force on charge q
4. $V = k\frac{q}{r}$
5. $energy = qV$

if E is constant, then

6. $V = E \times \text{distance}$

Capacitors

7. $C = \frac{Q}{V}; \quad C_{\parallel} = \varepsilon_o \frac{A}{d}; \quad U = \frac{1}{2}CV^2$

Electric Current

8. $I = \frac{\Delta q}{\Delta t}$

Resistors and Ohm's Law

9. $R = \frac{V}{I}; \quad R = \rho\frac{l}{A}$
10. $P = \frac{W}{t} = IV = I^2R = \frac{V^2}{R}$

Parallel Connections

11. $C_{eq} = C_1 + C_2 + C_3$
12. $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

Series Connections

13. $\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$
14. $R_{eq} = R_1 + R_2 + R_3$

Magnetism

15. $\vec{F} = q\vec{v} \times \vec{B}$; $F = qvB \sin\theta$
16. $\vec{F} = I\vec{l} \times \vec{B}$; $F = BlI \sin\theta$
17. $\tau = BNIA \sin\theta$, torque on a loop
18. $B = \frac{\mu_0 I}{2\pi r}$, field from a wire
19. $B = \mu_0 nI = \mu_0 \frac{N}{l} I$, field in a solenoid
20. $\frac{F}{\ell} = \mu_0 \frac{I_1 I_2}{2\pi d}$, force between wires
21. $\Phi = BA\cos\theta$, magnetic flux
22. $\mathcal{E} = -N\frac{\Delta\Phi}{\Delta t}$, induced emf
23. $\mathcal{E} = -L\frac{\Delta I}{\Delta t}$, for an inductor
24. $u = \frac{1}{2}\varepsilon_0 E^2; \quad u = \frac{1}{2}\frac{B^2}{\mu_0}$; = energy density

AC Circuits

25. $V_{rms} = \frac{1}{\sqrt{2}} V_{\max}$, $I_{rms} = \frac{1}{\sqrt{2}} I_{\max}$
26. $X_C = 1/(2\pi fC)$, $X_L = 2\pi fL$
27. $Z = \sqrt{R^2 + (X_L - X_C)^2}$
28. Power = $I_{rms} V_{rms} \cos\varphi$; $\cos\varphi = R/Z$

Optics Equations

29. $y = y_m \sin(kx - \omega t); \quad k = \frac{2\pi}{\lambda}; \quad \omega = 2\pi f; \quad v = f\lambda$
30. $n_1 \sin\theta_1 = n_2 \sin\theta_2$, where $n = \frac{c}{v}; \quad \lambda = \frac{\lambda_0}{n}$
31. $\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$; where f = $\frac{1}{2}R$ for mirrors
32. $\frac{1}{f} = (n-1)\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$; thin lenses, $\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$ lenses in contact
33. $m_t = \frac{h_i}{h_o} = -\frac{q}{p}; \quad m_\theta = \frac{\theta_{aided}}{\theta_{unaided}}$

double slits, constructive interference

34. $d\sin\theta = m\lambda$; where m = 0,1,2,. . .
35. $y_n = \frac{mL\lambda}{d}$; where m = 0,1,2, . . .

single slit, destructive interference

36. $a\sin\theta = m\lambda$, where m=1,2,3, ... ;

thin film in air, constructive interference in reflection

37. $t = \frac{\lambda}{4n}$

Relativity

38. $\gamma = \left[1 - \frac{v^2}{c^2}\right]^{-1/2}$
39. $\Delta t = \gamma \Delta t_0$; $L = \gamma^{-1} L_0$
40. $K = (\gamma - 1)m_0 c^2$
41. $v = \frac{v_1 - u}{1 - v_1 u / c^2}$
42. $E = mc^2 = \gamma m_0 c^2 = (c^2p^2 + m_0^2 c^4)^{1/2}$

Quantum Physics

43. $E = (n + 1/2)\, hf$, $n = 0, 1, 2, 3, \ldots$ Harmonic Oscillator
44. $E = hf$ photon
45. $\lambda = h/p$ deBroglie