

Physics Final Exam — 8.5×11 Cheat Sheet Template (FRONT)

Equations in light gray are hand-copy reference. Write over them in dark pen on your allowed sheet.

Ch 27 QUANTUM

Photon energy

$$E = hf = hc/\lambda \quad (hc = 1240 \text{ eV}\cdot\text{nm})$$

Photoelectric effect

$$K_{\text{max}} = hf - \Phi = e\cdot V_s$$

Threshold (no emission below)

$$f_0 = \Phi/h \quad \lambda_0 = hc/\Phi$$

X-ray minimum wavelength

$$\lambda_{\text{min}} = hc / (e\cdot\Delta V)$$

Wien's displacement law

$$\lambda_{\text{max}} \cdot T = 2.898 \times 10^{-3} \text{ m}\cdot\text{K}$$

Bragg's law (θ from PLANE)

$$2d \sin \theta = m\lambda$$

Compton shift (NOT λ_0 dep.)

$$\Delta\lambda = (h/m_e c)(1 - \cos \theta)$$

de Broglie wavelength

$$\lambda = h/(mv); \quad e^- \text{ shortcut: } 1.226/\sqrt{V} \text{ nm}$$

Heisenberg (position-momentum)

$$\Delta x \cdot \Delta p \geq \hbar/2 = h/(4\pi)$$

Heisenberg (energy-time)

$$\Delta E \cdot \Delta t \geq \hbar/2$$

Ch 28 ATOMIC

Bohr energy levels (H)

$$E_n = -13.6 / n^2 \text{ (eV)} \quad n=1,2,3,\dots$$

Bohr radii (H)

$$r_n = (0.0529 \text{ nm}) \cdot n^2$$

Hydrogen emission spectrum

$$hf = (-13.6 \text{ eV}) \cdot (1/n_i^2 - 1/n_f^2)$$

Get λ from ΔE

$$\lambda(\text{nm}) = 1240 / \Delta E(\text{eV})$$

Series: Lyman $n_f=1$ (UV)

Balmer $n_f=2$ (vis) Paschen $n_f=3$ (IR)

Four quantum numbers

$$n, \ell, m_\ell, m_s$$

Allowed values

$$\ell: 0 \dots n-1 \quad m_\ell: -\ell \dots +\ell \quad m_s: \pm 1/2$$

Pauli exclusion

no two e^- with same $\{n, \ell, m_\ell, m_s\}$

Max e^- per shell

$$2n^2 \quad (K=2, L=8, M=18, N=32)$$

Characteristic X-ray (Bohr w/ Z_{eff})

$$hf = -13.6 \cdot Z_{\text{eff}}^2 \cdot (1/n_i^2 - 1/n_f^2)$$

For $K\alpha$

$$Z_{\text{eff}} \approx Z - 1 \quad (\text{Moseley's law})$$

Ch 29 NUCLEAR

Nucleus radius

$$r = r_0 \cdot A^{1/3} \quad r_0 = 1.2 \text{ fm}$$

Notation

$${}^A_Z X \quad (N = A - Z \text{ neutrons})$$

Activity (decay rate)

$$R = \lambda N \quad [\text{Bq} = \text{decays/s}]$$

Decay law (continuous)

$$N(t) = N_0 \cdot e^{(-\lambda t)}$$

Decay law (n half-lives)

$$N = N_0 \cdot (1/2)^{(t/T_{1/2})}$$

Half-life

$$T_{1/2} = 0.693 / \lambda = \ln(2)/\lambda$$

Q value (energy released)

$$Q = (m_{\text{in}} - m_{\text{out}}) \cdot c^2$$

Threshold KE (endothermic only)

$$KE_{\text{min}} = (1 + m/M) \cdot |Q|$$

Mass-energy conversion

$$1 \text{ u} \cdot c^2 = 931.494 \text{ MeV}$$

1 curie

$$1 \text{ Ci} = 3.7 \times 10^{10} \text{ Bq}$$

Ch 30 + DIFFRACTION LAB

Mass-energy released

$$\Delta E = \Delta m \cdot c^2$$

Conservation law

$$\Sigma E_R(\text{initial}) = \Sigma E_R(\text{final}) + \Delta E$$

Conserve in nuclear reactions

A, Z, charge, energy, momentum

Fission (~200 MeV per event)



Fusion (~17 MeV per event)



DIFFRACTION (LAB)

Single-slit dark fringes

$$y_m = m\lambda L / a \quad m=1,2,3,\dots$$

Single-slit central width

$$w_0 = 2\lambda L / a \quad (\text{twice the others})$$

Double-slit dark fringes

$$y_m = (m + 1/2) \cdot \lambda L / d$$

Find λ from single slit

$$\lambda = w_0 \cdot a / (2L)$$

Find λ from double slit

$$\lambda = D_5 \cdot d / (9L) \quad (D_5 = \pm 5\text{th darks})$$

8.5x11 Cheat Sheet Template (BACK) – Constants & Quick-Recognition

If your professor allows only one side, skip this page.

Constants Strip (write in a single small row at top)

$h = 6.63 \times 10^{-34} \text{ J}\cdot\text{s} = 4.14 \times 10^{-15} \text{ eV}\cdot\text{s}$ | $\hbar = h/2\pi = 1.055 \times 10^{-34} \text{ J}\cdot\text{s}$ | $c = 3.00 \times 10^8 \text{ m/s}$
 $hc = 1240 \text{ eV}\cdot\text{nm}$ | $e = 1.60 \times 10^{-19} \text{ C}$ | $1 \text{ eV} = 1.60 \times 10^{-19} \text{ J}$
 $m_e = 9.11 \times 10^{-31} \text{ kg}$ | $m_e \cdot c^2 = 0.511 \text{ MeV}$ | $m_p \cdot c^2 = 939 \text{ MeV}$
 $\lambda_C = h/(m_e \cdot c) = 2.43 \times 10^{-12} \text{ m} = 2.43 \text{ pm}$ | $1 \text{ u} \cdot c^2 = 931.494 \text{ MeV}$
 $r_0 \text{ (nucleus)} = 1.2 \times 10^{-15} \text{ m} = 1.2 \text{ fm}$ | $a_0 \text{ (Bohr)} = 0.0529 \text{ nm}$ | $1 \text{ Ci} = 3.7 \times 10^{10} \text{ Bq}$

Common Work Functions Φ (eV) – for photoelectric problems

Cs: 1.9 Na: 2.3 K: 2.3 Cu: 4.5 W: 4.5 Pt: 5.6

Hydrogen Spectral Series (n_f labels)

Lyman $n_f = 1$ (UV) first line: $n=2 \rightarrow 1$, $\lambda = 121.6 \text{ nm}$
 Balmer $n_f = 2$ (visible) $H\alpha$ $n=3 \rightarrow 2$, $\lambda = 656.3 \text{ nm}$ (red); $H\beta$ $n=4 \rightarrow 2$, $\lambda = 486 \text{ nm}$ (cyan)
 Paschen $n_f = 3$ (IR) first line: $n=4 \rightarrow 3$, $\lambda = 1875 \text{ nm}$

Four Quantum Numbers (Pauli: no two e^- share all four)

n (principal): 1, 2, 3, ...
 l (orbital): 0, 1, 2, ..., $n-1$
 m_l (orbital mag.): $-l, -l+1, \dots, +l$ ($2l+1$ values)
 m_s (spin): $+\frac{1}{2}$ or $-\frac{1}{2}$
 Max electrons per shell n : $2 \cdot n^2$ (K=2, L=8, M=18, N=32)

Quick-Recognition: When you see X, grab formula Y

Trigger phrase	Formula to use
'blackbody', 'stellar peak'	$\lambda_{\text{max}} \cdot T = 2.898 \times 10^{-3} \text{ m}\cdot\text{K}$
'photon energy' given λ in nm	$E(\text{eV}) = 1240 / \lambda(\text{nm})$
'work function', 'stopping potential'	$K_{\text{max}} = hf - \Phi = e \cdot V_s$
'X-ray tube', 'minimum wavelength'	$\lambda_{\text{min}} = hc / (e \cdot \Delta V)$
'crystal', 'diffraction angle'	$2d \sin \theta = m \cdot \lambda$
'scattered off electron', given θ	$\Delta \lambda = \lambda_C \cdot (1 - \cos \theta)$
'accelerated electron', de Broglie λ	$\lambda(\text{nm}) = 1.226 / \sqrt{V}$
'hydrogen $n_i \rightarrow n_f$ '	$\Delta E = 13.6 \cdot (1/n_f^2 - 1/n_i^2) \text{ eV}$; $\lambda = 1240/\Delta E \text{ nm}$
'radius of hydrogen at n '	$r_n = 0.0529 \cdot n^2 \text{ nm}$
' $K\alpha$ X-ray of element Z'	Bohr formula with $Z_{\text{eff}} = Z - 1$
'after t years/half-lives'	$N = N_0 \cdot (\frac{1}{2})^{(t/T_{1/2})}$
'activity in Bq', given $T_{1/2}$ and N	$R = (0.693 / T_{1/2}) \cdot N$
'energy released' in nuclear reaction	$\Delta E = \Delta m \cdot 931.494 \text{ MeV}$ (Δm in u)
'fission' / 'fusion' Q value	$Q = (m_{\text{reactants}} - m_{\text{products}}) \cdot c^2$
'threshold energy' (endothermic)	$KE_{\text{min}} = (1 + m/M) \cdot Q $
'single slit, central bright width'	$w_0 = 2\lambda L/a \rightarrow \lambda = w_0 \cdot a / (2L)$
'double slit, m-th dark fringe'	$y_m = (m + \frac{1}{2}) \cdot \lambda L / d$
'distance between ± 5 th dark fringes'	$D_5 = 9\lambda L/d \rightarrow \lambda = D_5 \cdot d / (9L)$

Tips for Building Your Real Sheet

- Write small but legible (0.5 mm gel pen, ALL-CAPS for headers).
- Group by chapter like this template — when you flip to 'the Compton problem', go straight to the Ch 27 quadrant.
- Color-code if allowed: one color for formulas, another for constants/units. Black-only is safest.
- Include UNITS on the unusual constants (λ_C in pm, σ in $\text{W/m}^2 \cdot \text{K}^4$).
- Rehearse FINDING things on the sheet during the practice problems. If you can't locate a formula in 5 sec, the layout needs work.